PB87-910212

### SELECTED

# **SESOURCES**RESOURCES ABSTRACTS



VOLUME 20, NUMBER 12 DECEMBER 1987

W87-09602 -- W87-10112 CODEN: SWRABW **S** ELECTED WATER RESOURCES ABSTRACTS (SWRA) is produced by the Geological Survey, U.S. Department of the Interior, and published monthly by the National Technical Information Service (NTIS), U.S. Department of Commerce.

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## SELECTED WATER RESOURCES ABSTRACTS

A monthly publication of the Geological Survey U.S. Department of the Interior

VOLUME 20, NUMBER 12 DECEMBER 1987

W87-09602 -- W87-10112



The Secretary of the Interior has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Office of Management and Budget through September 30, 1988.

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#### PREFACE

S elected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the Water Resources Thesaurus. The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific Information Center U.S. Geological Survey MS 425 National Center Reston, VA 22092

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#### SELECTED WATER RESOURCES ABSTRACTS

#### 1. NATURE OF WATER

#### 1A. Properties

ISOTOPIC COMPOSITION AND ORIGIN OF LACUSTRINE BRINES IN THE ARCTIC, ebec Univ., Montreal. Dept. des Scie For primary bibliographic entry see Field 2H. W87-09919

#### 2. WATER CYCLE

#### 2A. General

SCALE PROBLEMS IN HYDROLOGY: RUNOFF GENERATION AND BASIN RE-

D. Reidel Publishing Co., Dordrecht, Holland. 1986. 246 p. Edited by V. K. Gupta, I. Rodriguez-Iturbe, and E. F. Wood. NSF Grant No. CEE-84-17682 and ARO Grant No. 22323-GS-CF.

Descriptors: \*Hydrological regime, \*Hydrology, \*Conferences, Mathematical studies, Sediment transport, Hydrologic properties, Flow discharge, Groundwater movement, Overland flow, Channel

The scale problems in hydrology and other geo-physical sciences stem from the recognition that the mathematical relationships describing a physi-cal phenomenon are mostly scale dependent in the sense that different relationships manifest at differ-ent space-time scales. The broad scientific problem then is to identify and formulate suitable relationent space-time scales. The broad scientific problem then is to identify and formulate suitable relationships at the scales of practical interest, test them experimentally and seek consistent analytical connections between these relationships and those known at other scales. For example, the current hydrologic theories of evaporation, infiltration, subsurface water transport and water sediment transport overland and in channels etc. derive mostly from laboratory experiments and therefore generally apply at 'small' space-time scales. A rigorous extrapolation of these theories to large spatial and temporal basin scales, as mandated by practical considerations, appears very difficult. Consequently, analytical formulations of suitable hydrologic theories at basin wide space-time scales and their experimental verification is currently being perceived to be an exciting and challenging area of scientific research in hydrology. In order to successfully meet these challenges in the future, a series of workshops was initiated. One such workshop on scale problems in hydrology was held at Princeton University, Princeton, New Jersey, during October 31-November 3, 1984. This workshop was the second in a series on this general topic. This book contains the papers presented at the second workshop. (See W87-0961) through W87-09610

#### RELATIVE ROLE OF HILLSLOPE AND NET-WORK GEOMETRY IN HYDROLOGIC RE-

Mississippi Univ., University. Dept. of Civil Engineering.
O. J. Mesa, and E. R. Mifflin

O. J. Messa, and E. K. Millin. IN: Scale Problems in Hydrology: Runoff Genera-tion and Basin Response, D. Reidel Publishing Co., Dordrecht, Holland. 1986. p 1-17, 9 fig, 25 ref. Army Research Office Grant No. 21078-GS.

Descriptors: \*Rainfall-runoff relationships, \*Model studies, \*Hydrograph analysis, \*Hydrologic properties, \*Hydrologic systems, \*Slopes, \*Mathematical studies, Hydrology, Runoff, Routing, Mathematical equations, Basins, Channel flow, Hydrographs

A simple model is developed to investigate the relative role of network geometry and hillslopes in basin response. The network geometry is quantified in a function, termed the width function, that reflects the distribution of runoff with flow dis-

tance from the outlet. The model consists of two components: the routing component of the initial distribution (width function) through the network by means of simplified diffusion approximation; and the hillslope component. The channel network geometry significantly influences the basin hydrograph even in a 'small' basin such as the one investigated here. The width function provides a good first step in quantifying the influence of the basin geometry on the hydrograph. Hillslope response consists of a combination of a flast component and a slow component. In this case study, only a small fraction of the total runoff appears in the network via a slow component. The recession function of the hydrograph for the entire basin in controlled by the slow component of the hydrograph is controlled by the fast component of the hillslope response. It is feasible to model the basin hydrograph directly at the fast component of the hillslope response. It is feasible to model the basin hydrograph directly at the fast component of the hydrograph directly at the subject of the network via its link structure plays the most important role. The typical physical parameters that appear in this study are the width function, link magnitude, drainage density, mean link slope and mean flow velocity for the network, and the fast slow hillslope response component weights and velocities. (See also W87-09610) (Lantz-PTT) tance from the outlet. The model consists of two

NONLINEARITY AND TIME-VARIANCE OF THE HYDROLOGIC RESPONSE OF A SMALL

MOUNTAIN CREEK,
Consiglio Nazionale delle Ricerche, Turin (Italy).
Ist. di Ricerca per la Protezione Idrogeologica nel
Bacino Padano.

Bacino Padano. E. Caroni, R. Rosso, and F. Siccardi. IN: Scale Problems in Hydrology: Runoff Genera-tion and Basin Response, D. Reidel Publishing Co., Dordrecht, Holland. 1986. p 19-37, 8 fig. 5 tab, 19

Descriptors: \*Mountain streams, \*Hydrological regime, \*Time series analysis, \*Rainfall-runoff relationships, \*Mathematical studies, Alpine regions, Surface runoff, Model studies, Catchment areas, Flow velocity, Flooding, Mathematical equations.

riow velocity, Flooding, Mathematical equations. The dynamic nature of the hydrologic response of a small alpine catchment was examined. The time-scale of the catchment response to an input of rainfall excess depends mainly on the peak flow rate of the surface runoff. A nonlinear model, providing for variable time-scale or lag-time, should therefore be parameterized in terms of geomorphologic and hydraulic characteristics of the catchment in order to represent the rainfall-runoff transformation. Moreover, nonlinearity is found to decrease with increasing storm intensity. The linear assumption can thus represent quite satisfactorily this transformation in order to perform major flood analyses also for 'small' catchments, i.e., at the 'elementary' basin scale. Reliable estimates of the bankfull discharge are required for the purpose of estimating the average time-space streamflow velocity in this case. (See also W87-09536) (Author's abstract)

RUNOFF SIMULATION MODEL BASED ON HILLSLOPE TOPOGRAPHY, Leeds Univ. (England). School of Geography.

M. Kirkly.
IN: Scale Problems in Hydrology: Runoff Genera-tion and Basin Response, D. Reidel Publishing Co., Dordrecht, Holland. 1986. p 39-56, 6 fig, 1 tab, 13

Descriptors: \*Rainfall-runoff relationships, \*Surface-groundwater relations, \*Simulation analysis, \*Model studies, \*Runoff forecasting, \*Slopes, To-gorgaphy, TOPMODEL, Computer programs, Mathematical studies, Mathematical equations, Channel flow, Saturated flow, Infiltration, Unsaturated flow, Forecasting, Flow profiles, Hydro-

The detailed model presented is a development of an exponential store model (TOPMODEL). The continuity equations for saturated subsurface flow

is expressed in terms of unit runoff which empha-sizes the relatively low spatial variation in rates. sizes the relatively low spatial variation in rates. For this reason, kinematic wave solutions have not been used to solve the partial differential equation. A single unsaturated and a saturated store are considered at each point down the hillslope length, the former delaying infiltration and the latter providing downslope subsurface flow and establishing saturated contributing areas. The total subsurface flow at saturation, slope gradient and hillslope plan form are used to generate flow differences down the length of the hillslope profile. Simulations show the generation of saturated overland flow at downslope sites where flow converges, superimposed on a hydrography which is largely controlled by the convex (in profile) divide area. This suggests that for most natural slopes, the runoff suggests that for most natural slopes, the runoff delivered to channel banks may be estimated effi-ciently from two separate linked component models. The first forecasts spatially uniform flow at rates determined by topography and soils in the hilltop divide areas. This model is able to forecast the changing saturated area on which the second component model forecasts the saturated overland flow. This or another appropriate hillslope flow model may be combined with a flow routing algo-rithm for the channel network to given catchmet hydrological response. (See also W87-09536) (Author's abstract)

GEOMORPHOLOGIC APPROACH TO SYN-THESIS OF DIRECT RUNOFF HYDROGRAPH FROM THE UPPER TIBER RIVER BASIN,

Consiglio Nazionale delle Ricerche, Perugi (Italy). Ist. di Ricerca per la Protezione Idrogeolo gica nell' Italia Centrale.

C. Corradini, F. Melone, L. Ubertini, and V. P.

Singin.

IN: Scale Problems in Hydrology: Runoff Generation and Basin Response, D. Reidel Publishing Co., Dordrecht, Holland. 1986. p 57-79, 15 fig, 8 tab, 23 ref. NSF Grant No. NSF-CEE 79-07793.

Descriptors: "Rainfall-runoff relationships, "Hydrograph analysis, "Geomorphology, "Direct flow, "Unit hydrographs, "Runoff, "Hydrographs, "Tiber River, "Italy, Infiltration, Sensitivity analysis, Model studies, Mathematical studies, Flood

The effective rainfall-direct runoff relationship was investigated for forty events on four large basins by using a geomorphologic representation of the instantaneous unit hydrograph (IUH). These basins are a part of the Upper Tiber River basin located in Central Italy and range in area from 934 sq km to 4,147 sq km. For each event the volume of direct runoff was obtained by hydrograph separation. The effective rainfall hydrograph was then determined by using the two-term Philip infiltration equation in conjunction with a volume balance analysis. The geomorphologic parameters required by the IUH were extracted from a topographic map of each basin with the map scale of 1:200,000. It was found that the dimensionless form of the IUH remained practically constant from one basin IUH remained practically constant from one basin to another. By convoluting the geomorphologic IUH, derived for each basin, with the effective rainfall, the direct runoff hydrograph was synthesized for each event. The model results compare reasonably well with observations of each basin. reaconably well with observations of each basin. The maximum and mean errors in computing peak flow were 33% and 15% respectively. Furthermore, the magnitudes of these errors did not depend upon the basin area. A sensitivity analysis of the model structure revealed that its order of geomorphologic representation could be reduced by at least one without a significant loss of accuracy. This small reduction in order amounted to a considerable reduction in geomorphologic complexity and computational effort. The model results were quite sensitive to basin lag and sorptivity parameter of the infiliration equation. A 10% variation of computed peak discharge. However, a 10% variation of computed peak discharge. However, a 10% variation of yow mean variation in computed peak discharge. (See also W87-09536) (Author's abstract) W87-09614

#### Group 2A-General

SPATIAL HETEROGENEITY AND SCALE IN THE INFILTRATION RESPONSE OF CATCH-MENTS.

MENTS, Princeton Univ., NJ. Dept. of Civil Engineering. M. Sivapalan, and E. F. Wood. IN: Scale Problems in Hydrology: Runoff Genera-tion and Basin Response, D. Reidel Publishing Co., Dordrecht, Holland. 1986. p 81-106, 17 fig., 22 ref. NSF Grant No. CEE-8100491 and NASA Grant No. NAG-5/491.

Descriptors: \*Surface-groundwater relations, \*Spatial heterogeneity, \*Infiltration, \*Catchment areas, Soil water, Rainfall, Mathematical studies, Rainfall infiltration.

The effect of spatial heterogeneity in soil and rainfall characteristics on the infiltration response of catchments is studied. Quasi-analytical expressions are derived for the statistics of the ponding time and the infiltration rate for two cases: (1) spatially variable soils and uniform rainfall, and (2) constant soil properties and spatially variable rainfall. The derivations show that the cumulative ponding time distribution is a critical variable which governs the mean and covariance of the infiltration process. This distribution determines the proportion of the catchment which is soil controlled and the proporcatchment which is soil controlled and the propor-tion which is rainfall controlled. The heterogeneity of the infiltration response, part being rainfall con-trolled and part soil controlled, causes a temporal variation in the correlograms. Over time, the cor-relation of the infiltration goes from the correlo-gram of the rainfall (at initial time) to that of the soil properties (at large time). (See also W87-09536) (Author's abstract)

RUNOFF PRODUCTION AND FLOOD FRE-QUENCY IN CATCHMENTS OF ORDER N: AN ALTERNATIVE APPROACH, Lancaster Univ. (England). Dept. of Environmen-

tal Sciences K. Beven

K. Beven.
IN: Scale Problems in Hydrology: Runoff Generation and Basin Response, D. Reidel Publishing Co., Dordrecht, Holland. 1986. p 107-131, 7 fig, 5 tab,

Descriptors: \*Rainfall-runoff relationships, \*Flood frequency, \*Simulation analysis, \*Runoff, \*Catchment areas, \*Model studies, Hydrologic models, Soil water, Flood forecasting, Rainfall, Storms, Mathematical studies, Flood peak.

A simple physically-based hydrological model is derived that takes account of the effect of spatial heterogeneities of topography and soil on runoff production. Both infiltration excess and saturation excess mechanisms of runoff production are simulated by the model. The model is computationally inexpensive and has been used to derive flood frequency characteristics for three small catch-ments by simulating hydrographs during a 100 year record of randomly generated rainstorms. Inter-storm calculations are carried out analytically. For the range of parameter values studied it was found that all the maximum annual flood peak distributions are of extreme value 1 (Gumbel) type. The normalized distribution functions (growth curves) are remarkably similar over all the parameter sets considered. Runoff production in flood events for considered. Runoir production in nood events for all the simulations was dominated by the saturation excess mechanism, even assuming very high hydraulic conductivities, and even where infiltration excess runoff is predicted as occurring over part of the catchment. It appears to be difficult to avoid surface saturation under the wet conditions associated with floods in a climatic regime typical of upland Britain. (See also W87-09536) (Author's abstract) W87-09616

STUDY OF SCALE EFFECTS IN FLOOD FRE-

QUENCY RESPONSE, University Coll., Galway (Ireland). Dept. of Engineering Hydrology. C. S. Hebson, and E. F. Wood.

C. S. Hesson, and E. F. Wood. IN: Scale Problems in Hydrology: Runoff Genera-tion and Basin Response, D. Reidel Publishing Co., Dordrecht, Holland. 1986. p 133-158, 6 fig, 3 tab,

37 ref. NSF Grant No. CME-79-15168.

Descriptors: \*Flood frequency, \*Mathematical studies, \*Catchment areas, \*Rainfall-runoff relationships, Model studies, Runoff, Mathematical analysis, Probabilistic process, Storms, Correlation analysis.

The effects of relative climatic and catchment scales on flood frequency response are studied with the aid of a dimensionless derived flood fre-quency equation. The dimensionless frequency is quency equation. The dimensionless frequency is developed by applying the method of derived dis-tributions from probability theory to an Instantane-ous Unit Hydrograph (IUH) runoff model and a probabilistic areal rainfall model. The derived dis-tribution approach provides a theoretical frametribution approach provides a theoretical framework for treating the scale interactions in a systematic way, while the dimensionless formulation makes for a straightforward generalization of the results. The component models in the frequency are characterized by various scales, so that the frequency itself is an implicit function of those scale effects. Catchment/climate interaction works in two notable ways: (1) through the ratio of characterizities storm duration to catchment of characteristic storm duration to catchment response time, and (2) through the shape of the input areal rainfall intensity distribution as it is affected areal rainfall intensity distribution as it is affected by the relative correlation and catchment scales, these two parameters have opposite effects on fre-quency skewness. However, in most cases the area averaging effect is dominant and the net effect shows that flood frequency behavior in small catchments should be flashier and more highly skewed than in large catchments. These same properties are often observed in real data. (See also W87-09536) (Author's abstract) W87-09617

SCALES, GRAVITY AND NETWORK STRUCTURE IN BASIN RUNOFF,

Mississippi Univ., University. Dept. of Civil Engineering

V. K. Gupta, E. Waymire, and I. Rodriguez-

IN: Scale Problems in Hydrology: Runoff Genera-tion and Basin Response, D. Reidel Publishing Co., Dordrecht, Holland. 1986. p 159-184, 18 fig, 1 tab, 29 ref. Army Research Office Grant No. 21078-

Descriptors: \*Hydrological regime, \*Basins, \*Gravity, \*Runoff, Catchment areas, Saturated flow, Unsaturated flow, Soil water, Erosion, Sediment transport, Mathematical studies, Drainage, Mathematical equations, Statistical analysis, Groundwater movement, River basins.

Runoff generation and its transmission to the outlet from an ungaged river basin having an identifiable channel network are considered at the basin scale. This scale is much larger than the hydrodynamic scale, where the equations governing the transport of water overland and in saturated and unsaturated soils are best understood. Gravity, via altitude, plays the fundamental role in both the transport of water as well as in network formation via erosion and sediment transport. So, here altitude is identi-fied as the natural parameter for physically rigor-ous descriptions of network structures in the conous descriptions of network structures in the context of hydrologic investigations at the basin scale.

In this connection an empirical postulate is made
on the link heights as being independent but possibly non-homogeneous random variables having an
exponential distribution. Data from six river basins
ranging in sizes from 1 sq km to 100 sq km and
from different climatic regions are used to test the
suitability of this postulate. The drainage scaling
parameter is introduced as the number of links per
unit area density in an infinitesimal increment of
the altitude at the basin scale. Data from five of the
six basins is analyzed to show qualitatively that the altitude at the basin scale. Data from five of the six basins is analyzed to show qualitatively that these basins are homogeneous with respect to drainage scaling parameter. This homogeneity along with that in the exponential nature of the link heights are used to illustrate that the total runoff generated by the sub-basin associated with any link of a basin, has a gamma distribution. (See also W87-09536) (Author's abstract) W87-09618

INCORPORATION OF CHANNEL LOSSES IN THE GEOMORPHOLOGIC IUH.

husetts Inst. of Tech., Cambridge. Dept. of

Massachusetts inst. of Tech., Cambridge. Dept. of Civil Engineering. M. Diaz-Granados, R. L. Bras, and J. B. Valdes. IN: Scale Problems in Hydrology: Runoff Genera-tion and Basin Response, D. Reidel Publishing Co., Dordrecht, Holland. 1986. p 217-243, 16 fig, 2 tab,

Descriptors: \*Unit hydrographs, \*Surface-ground-water relations, \*Rainfall-runoff relationships, \*Geomorphology, \*Channel loss, \*Infiltration, Hy-drographs, Mathematical analysis, Mathematical studies, Linear analysis, Channel flow.

The infiltration losses along the stream channels of a basin are included into the Instantaneous Unit Hydrograph (IUH). The IUH is derived as a func-tion of the basin geomorphological and physiogra-phic characteristics, and the response of the indi-vidual channels to upstream and lateral inflows. This response is obtained by solving the linearized Ints response is obtained by solving the interarzed continuity and momentum equations, including approximate infiltration losses terms, for the boundary conditions established by the definition of a linear system response to an instantaneous unit input. A methodology is proposed for the estimation of the parameters involved in the channel response. Based on this result a procedure is aug. response. Based on this result, a procedure is sug-gested to include infiltration losses in the common linear reservoir representation of channel seg-ments. Comparisons indicate that this approximation is adequate under certain conditions. (See also W87-09536) (Author's abstract) W87-09620

DELINEATION AND CORRELATION OF SA-LINITY TO LANDFORMS AND GEOLOGIC FORMATIONS, UPPER COLORADO RIVER

BASINS, California Univ., Davis. Dept. of Land, Air and

Water Resources. L. D. Whittig, A. E. Deyo, K. K. Tanji, and C. E.

L. D. Whittig, A. E. Deyo, K. K. Tanji, and C. E. Higgins.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-176244/
AS. Price codes: A08 in paper copy, A01 in microfiche. Land, Air and Water Resources Paper No. 100012, July 1986. 143 p, 46 fig, 3 tab, 57 ref, 2 append. USGS Contract No. 14-34-0001-0521.

Descriptors: \*Colorado, \*Upper Colorado River basin, \*Salinity control, \*Dissolved mineral salts, \*Landform-salinity maps, Grand Valley, Gunnison River Valley, Salinity, Landforms, Geologic for-mations, Maps, Saline seeps, Saline springs, Groundwater movement, Erosion, Sediment yield, Pedimentation, Watershed management.

This investigation was aimed at assessment of the potential contribution of dissolved mineral salts by natural lands in the Grand and Gunnison River Valleys in the Upper Colorado River Basin. The Mancos, Sego and Mount Garfield formations, are important contributors of soluble salts. Springs and seeps within the study area are highly localized, but result in significant differences in water quality but result is significant differences in water quantry and discharge between nearly identical adjoining watersheds. Active saline seeps and springs are common within the Grand Valley study section, but they are limited within the Gunnison River Valley study section. In some areas the springs reach salinity levels of 80 dSm-1. The majority of reach sanning revers of so dash-1. In emajority or salts leave some ic.cal watersheds by groundwater flow through buried stream channels. The close correspondence between salinity and landforms provided the basis for construction of landformprovided the basis for construction of landform-salinity maps covering approximately 1070 sq km within the Grand Valley and Gunnison River Valleys. Salt-contributing seeps and springs were also located on a map of the Grand Valley section of the study area. To decrease the salinity contributions from the wildlands, it is proposed that: (1) good quality groundwater be intercepted and used locally or transported past highly saline areas; (2) saline groundwater, which reaches as high as 80 GSm-1, be intercepted and transported to evaporation ponds; and (3) erosion resulting in sediment and salt production be controlled through use of gully plugs and sediment retention dams, reversing the present dissection of the pediments. This pro-

#### WATER CYCLE-Field 2

#### Precipitation—Group 2B

gram would decrease erosion, sediment yield and salt yield while increasing wildland water and vegetation. (USGS) W87-09771

VARIABLE SOURCE AREAS OF WATERSHED RUNOFF IN A SMALL FOREST WATERSHED: PHASE I,

Washington State Univ., Pullman. Dept. of Forestry and Range Management.
For primary bibliographic entry see Field 4D. W87-09794

COLLECTING, PREPARING, CROSSDATING, AND MEASURING TREE INCREMENT CORES,

Geological Survey, Reston, VA. Water Resources

Div.
R. L. Phipps.
Available from USGS, OFSS, Box 25425, Denver,
CO 80225. USGS Water-Resources Investigations
Report 85-4148, 1985. 48 p, 44 fig. 3 ref.

Descriptors: \*Trees, \*Core sampling, \*Radial increment cores, Methodology, Increment borers.

Techniques for collecting and handling increment tree cores are described. Procedures include those for cleaning and caring for increment borers, ex-tracting the sample from a tree, core surfacing, crossdating, and measuring. (USGS) W87-09853

COMPUTATION OF FLOOD FLOWS IN OPEN

Institut za Vodoprivredu Jaroslav Cerni, Belgrade For primary bibliographic entry see Field 2E. W87-09903 (Yugoslavia)

SATELLITE HYDROLOGY. For primary bibliographic entry see Field 7B. W87-09953

REMOTE SENSING IN HYDROLOGY - A CHALLENGE TO SCIENTISES, Geological Survey, Reston, VA. For primary bibliographic entry see Field 7B. W87-0995

NASA WATER RESOURCES/HYDROLOGY REMOTE SENSING PROGRAM IN THE

National Aeronautics and Space Administration, Washington, DC. For primary bibliographic entry see Field 7B. W87-09956

CORPS OF ENGINEERS UTILIZATION OF SATELLITES FOR HYDROLOGIC PURPOSES, Corps of Engineers, Washington, DC. Hydraulics and Hydrology Branch. For primary bibliographic entry see Field 7B. W87-09957

REVIEW OF CANADA'S PRESENT FUTURE REMOTE SENSING ACTIVITIES RE-LATING TO HYDROLOGY. National Hydrology Research Inst., Ottawa (Ontario).

For primary bibliographic entry see Field 7B. W87-09959

SATELLITE VERSUS OF METHODS IN HYDROLOGY, CONVENTIONAL Geological Survey, Reston, VA.
For primary bibliographic entry see Field 7B.
W87-09960

SATELLITE TELEMETRY OF HYDROLOGIC DATA IN CALIFORNIA,
California State Dept. of Water Resources, Sacramento. Div. of Flood Management.

For primary bibliographic entry see Field 7B. W87-09964

U.S. GEOLOGICAL SURVEY APPLICATION OF SATELLITE TELEMETRY FOR THE SUPPORT OF HYDROLOGIC DATA COLLEC-

Geological Survey, Reston, VA. For primary bibliographic entry see Field 7B. W87-09966

MODELING THE TERRESTRIAL HYDROLOGY FOR THE GLOBAL ATMOSPHERE: THE FUTURE ROLE OF SATELLITE DATA, cticut Univ., Storrs. Dept. of Civil Engi-

J. D. Lin, P. Bock, and J. J. Alfano. I.S. Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 124-138, 9 fig. 14 ref.

Descriptors: \*Model studies, \*Hydrologic data, \*Remote sensing, \*Satellite technology, Soil water, Groundwater, Surface flow, Data acquisition.

Groundwater, Surface flow, Data acquisition.

A global terrestrial hydrology model has been developed for the transport and storage of moisture and heat in the ground surface layer where the hydrological parameters react to diurnal and seasonal changes in the atmosphere. The spatial and temporal variability of land surface features is considered in the model by means of large scale parameterizations. The model can be either forced by the atmosphere using conventional meteorological data or coupled to an atmospheric general circulation model (GCM) for interactive studies. The global surface is divided into 4 degree longitude by 5 degree latitude cells while the ground is represented by a thin surface layer, a bulk layer (the root zone), and a deep layer (the groundwater zone). Results are presented from a seven-day global experiment which was conducted utilizing the GLAS GCM (NASA Goddard Laboratory for Atmospheric Sciences). The model has demonstrated its capability to predict, over a large region, the overall soil moisture storage and major flux exchanges with the atmosphere above and the groundwater below. The description and results of the model point to the need for large scale, long term data collection, especially by satellite and remote sensing techniques. (See also W87-09953) (Author's abstract)

ROLES OF SATELLITES IN HYDROLOGY. Geological Survey, Reston, VA. For primary bibliographic entry see Field 7B. W87-09977

#### 2B. Precipitation

ACID RAIN AND DRY DEPOSITION, Oklahoma Univ., Norman. Environmental Ground Water Inst. For primary bibliographic entry see Field 5B. W87-09624

ORGANIC COMPONENTS IN BULK AND WET-ONLY PRECIPITATION, Oregon State Univ., Newport. Marine Science For primary bibliographic entry see Field 5A. W87-09628

CLIMATOLOGY OF THE SIERRA NEVADA BARRIER JET.

Wyoming Univ., Laramie. Dept. of Atmospheric

S. W. Smutz.

Available from the National Technical Information Service, Springfield, Virginia 22161, as PB87-171146, A06 in paper copy, A01 in microfiche, Report No. AS 153, August 1986. 108 p, 36 fig, 4 tab, 18 ref. Bureau of Reclamation Contract No. 2-07-81-V0256.

Descriptors: \*Climatology, \*Sierra Nevada, \*California, \*Barrier jet, Cloud physics, Storms, Model studies, Air masses, Air circulation, Wind velocity.

The Sierra Nevada barrier jet (BJ) is a mountain-The Sierra Nevada barrier jet (BI) is a mountain-parallel low level jet that is frequently observed in the foothills region of the Sierra Nevada. Serial rawinsondes have been obtained near the base of the Sierra barrier, at Sheridan, California, by the Sierra Cooperative Pilot Project since 1977. The rawinsondes were launched during storm episodes that occurred near the barrier. More than 1800 of these countings are utilized to compile statistical characteristics of the barrier jet, examine the ef-fects of the melting layer on the speed and height of the barrier jet, and examine the dependence of of the barrier jet, and examine the dependence of barrier jet strength on thermodynamic stability of the subcrest airmass. The stability relationship is compared to previous numerical model results. A few key findings are: (1) the barrier jet is not diurnally dependent, but is easonally dependent with respect to speed; (2) effects of melting may influence speed, but not height of the barrier jet; and (3) the available data cannot be used to confirm the theoretical dependence of BJ strength vs. stability. (Author's abstract)

SCPP METEOROLOGICAL AND STATISTICAL SUPPORT FOR PERIOD 1 SEPTEMBER 1985 - 31 AUGUST 1986, VOLUME II (EXPERIMENTAL DAY SUMMARIES): INTERIM PROGRESS REPORT, Electronic Techniques, Inc., Fort Collins, CO. G. L. Hemmer, A. W. Huggins, R. M. Rauber, T. F. Lee, and A. P. Kuciauskas. Available from the National Technical Information Service, Springfield, Virginia 22161. September 1986, 82 p. 64 fig., 3 tab. Bureau of Reclamation Contract No. 4-CR-81-03860.

Descriptors: \*Sierra Cooperative Pilot Project, 
\*Meteorology, \*Statistical studies, \*Cloud seeding, 
\*Model studies, Forecasting, Storms, Clouds, Climatology, Orographic Remote sensing. precipitation,

The operational and scientific contributions to the Sierra Cooperative Pilot Project (SCPP) are docu-mented. Operational methods and data collection procedures are briefly described. The first scientific articles describe the status of the SCPP targeting ic articles describe the status of the SCPP targeting model, present targeting results from past seeding cases and describe important changes to be made to the model. The next articles discuss three case studies involving airborne seeding designed to impact a fixed target. The cases describe the synoptic, meso, and microscale structure of the storms with emphasis on the natural cloud evolution and the effects of seeding. A model for the evolution of large (>150 micron) cloud droplets is presented in one of these cases. A subsequent article deals with climatological investigations of a variety of meteorological parameters and shows how the seasonal or diurnal distribution of these parameters effect seeding opportunity. The final article compares supercooled liquid water measurements before and after frontal rainband passages and discusses short term forecasting these events using radar. A series of four articles by scientists from the North American Weather Consultants (NAWC) conclude the of four articles by scientists from the North American Weather Consultants (NAWC) conclude the analyses. One discusses diurnal trends in radiometer data. The second presents results of analyzing precipitation data (observed versus predicted) from past ground seeding operations by the Sacramento Municipal Utility District. The third shows another technique for analyzing precipitation data downwind of seeding suing 15-min data maps. The final article presents results of an experiment where three forecasters attempted to forecast the cocurrence of supercooled liquid water near the crest of the American River Basin. (Author's abstract) stract) W87-09686

EFFECTS OF RADIATIVE PROCESSES IN

THIN CIRRUS, State Univ. of New York at Albany. Dept. of Atmospheric Science. D. O. Starr.

Journal of Geophysical Research (D) JGRDE3,

#### **Group 2B—Precipitation**

Vol. 92, No. 4, p 3973-3978, April 1987. 5 fig, 3 tab, 10 ref. NSF Grant ATM-8420088.

Descriptors: \*Radiative processes, \*Numerical analysis, \*Cirrus, \*Clouds, \*Simulation, Convection, Atmosphere, Weather, Winds.

Results of four numerical simulations of convective thin cirrus are presented. Midday and nighttime cases at subtropopause (-60 C) and (-35 C) levels are considered. Each case is weakly forced by large-scale ascent. Radiative processes are shown large-scale ascent. Radiative processes are snown to strongly regulate the convective structure and ice water budget of the cloud (30% denser at night). Day-night differences result primarily from radiative modulation of buoyancy and the resultant differences in the organization of convection. The nature of this coupling between radiative processes and cloud circulations is discussed. The direct effects of radiative heating or cooling on the satura-tion vapor pressures are found to be of secondary importance in these convective cases. (Author's abstract) W87\_09691

DYNAMIC THRESHOLD METHOD FOR OB-TAINING CLOUD COVER FROM SATELLITE

IMAGERY DATA, National Center for Atmospheric Research, Boul-

For primary bibliographic entry see Field 7C. W87-09692

CLOUD TYPE CLASSIFICATION WITH NOAA Meteorological Research Inst., Yatabe (Japan). For primary bibliographic entry see Field 7B. W87-09693

SURFACE-OBSERVED AND SATELLITE-RE-TRIEVED CLOUDINESS COMPARED FOR THE 1983 ISCCP SPECIAL STUDY AREA IN

EUROPE, Liverpool Univ. (England). Dept. of Geography. For primary bibliographic entry see Field 7B. W87-09694

CLOUD FIELDS RETRIEVED FROM ANALY-SIS OF HIRS2/MSU SOUNDING DATA, National Aeronautics and Space Administration, Greenbelt, MD. Lab. for Atmospheric Sciences. For primary bibliographic entry see Field 7B. W87-09695

CLOUD COVER OVER THE EQUATORIAL EASTERN PACIFIC DERIVED FROM JULY 1983 INTERNATIONAL SATELLITE CLOUD CLIMATOLOGY PROJECT DATA USING A HYBRID BISPECTRAL THRESHOLD

National Aeronautics and Space Administration, Hampton, VA. Langley Research Center. For primary bibliographic entry see Field 7B. W87-09696

ROLE OF EARTH RADIATION BUDGET STUDIES IN CLIMATE AND GENERAL CIR-CULATION RESEARCH,

National Center for Atmospheric Research, Boulder, CO.

For primary bibliographic entry see Field 7B. W87-09697

MEASUREMENTS OF SURFACE ENERGY BUDGETS IN THE ROCKY MOUNTAINS OF Colorado State Univ., Fort Collins. Dept. of At-

mospheric Science.
For primary bibliographic entry see Field 7C.
W87-09698

MASS ACCOMMODATION COEFFICIENT FOR HO2 RADICALS ON AQUEOUS PARTI-CLES.

National Center for Atmospheric Research, Boul-

For primary bibliographic entry see Field 5B. W87-09699

PROBLEMS IN INTERPRETATION OF POWER SPECTRA OF CLOUD FIELDS. COMMONWER SPECTRA OF CLOUD FIELDS, Commonwealth Scientific and Industrial Research Organization, Aspendale (Australia). Div. of At-mospheric Research. For primary bibliographic entry see Field 7C. W87-09700

NUMERICAL MODELING STUDY OF A MON-TANA THUNDERSTORM: 1. MODEL RE-SULTS VERSUS OBSERVATIONS INVOLVING NONELECTRICAL ASPECTS, South Dakota School of Mines and Technology, Pacid City Laws of Astrophysic Soil

Rapid City. Inst. of Atmospheric Sciences.
J. H. Helsdon, and R. D. Farley.
Journal of Geophysical Research (D) JGRDE3,
Vol. 92, No. 5, p 5645-5659, May 1987. 8 fig. 1 tab,
27 ref, append. NSF Grant ATM-8313484.

Descriptors: \*Model studies, \*Numerical analysis, \*Thunderstorms, \*Dynamic threshold method, \*Satellite imagery, \*Cloud size, \*Data interpretation, Estimating, Remote sensing, Cloud liquid water, Simulation.

water, Simulation.

A recently developed Storm Electrification Model (SEM) has been used to simulate the July 19, 1981, Cooperative Convective Precipitation Experiment (CCOPE) cloud case study. This part of the investigation examines the comparison between the model results and the observations of the actual cloud with respect to its nonelectrical aspects. A timing equivalence is established between the simulation and observations based on an explosive growth phase which was both observed and modeled. This timing equivalence is used as a basis upon which the comparisons are made. The model appears to do a good job of reproducing (in both space and time) many of the observed characteristics of the cloud. These include: (1) the general cloud appearance; (2) cloud size; (3) cloud top rise rate; (4) rapid growth phase; (5) updraft structure; (6) first graupel appearance; (7) first radar echo; (8) qualitative radar range-height indicator evolution; (9) cloud decay; and (10) the location of hydrometers with respect to the updraft/downdraft structure. Some features that are not accurately modeled are the cloud base height the maximum limit eters with respect to the uporart/downart struc-ture. Some features that are not accurately mod-eled are the cloud base height, the maximum liquid water content, and the time from first formation of precipitation until it reaches the ground. While the simulation is not perfect, the faithfulness of the model results to the observations is sufficient to give us confidence that the microphysical process-es active in this storm are adequately represented in the model physics. Areas where model improve-ment is indicated are also discussed. (Author's abstract)

NUMERICAL MODELING OF HAILSTORMS AND HAILSTONE GROWTH. PART II: THE ROLE OF LOW-DENSITY RIMING GROWTH IN HAIL PRODUCTION,
South Dakota School of Mines and Technology,

W87-09701

South Dakota School of Mines and Technology, Rapid City. Inst. of Atmospheric Sciences. R. D. Farley. Journal of Climate and Applied Meteorology JCAMEJ, Vol. 26, No. 2, p 234-254, February 1987. 11 fig. 56 ref. NSF Grants ATM-7916147, ATM-8311548 and ATM-8603308.

Descriptors: \*Riming growth, \*Hailstorms, \*Model studies, \*Hail, \*Numerical analysis, \*Clouds, Atmosphere, Storms, Weather, Ice.

The past several years have seen a renewed interrice is not seen a years law seen a renewed microstroper set in the importance of low-density riming growth to the development of halistones. This paper reports on the results of a study that incorporates the physical factors controlling the density of the rime deposit in a two-dimensional, time-dependent nu-merical cloud model with discretized treatment of the graupel/hail size distribution. Comparisons are made between cases in which the mass-diameter relationship is fixed based on a priori assumed particle densities and cases in which the mass-

diameter relationship is allowed to change in ac-cordance with the variable particle density diagcordance with the variance particle density diagrams on sed from the riming density relationship and past growth history. Compared to the fixed particle density treatment common to earlier work, ice particles of lower density have enhanced surface and cross-sectional area for particles of equal mass, which in turn, increases the effective ventilation which in turn, increases the effective ventilation experienced by the particles and their capture volumes, thus allowing enhanced diffusional and accretional growth. The lower density particles also experience reduced sedimentation effects due to reduced fallspeeds. This leads to increased residence time in favorable growth environments for both the low density embryos in the region of the embryo curtain and for medium density particles growing to hall in the more active regions of the cloud. (Author's abstract)

W87.09702 W87\_00702

SENSITIVITY STUDIES ON THE CONTINENTALITY OF A NUMERICALLY SIMULATED CUMULONIMBUS,

Ophir Corp., Lakewood, CO. R. Banta, and K. R. Hanson.

Journal of Climate and Applied Meteorology JCAMEJ, Vol. 26, No. 2, p 275-286, February 1987. 12 fig, 2 tab, 22 ref, append.

Descriptors: \*Model studies, \*Precipitation, \*Rainfall, \*Simulation, \*Clouds, \*Numerical analysis, Graupel, Ice, Riining, Storms.

The cloud model of Tripoli and Cotton was used to simulate a cumulonimbus cloud observed during the Cooperative Convective Precipitation Experiment (CCOPE). The sensitivity of the precipitation pathways in the model to the initial concentration of cloud droplets above cloud base N sub c (which is related to the concentration of cloud condensation nuclei) was tested. The results showed that for large N sub c, Manton and Cotton's autoconversion parameterization properly suppressed superarge rs sub c, mainton and cotton's autoconver-sion parameterization properly suppressed super-cooled rain formation via the 'warm-rain' process in a cold-based, continental cloud, forcing ice processes (e.g., riming, aggregation and deposition of vapor) to produce graupel. With lower droplet concentrations, rain formed first through warmrain processes, then graupel formed through freezing. The value of N sub c which determined the transition from graupel formation by freezing rain to graupel formation by ice processes was found to to grauper formation by the processes was found to be sensitive to the parameter a sub cm, which represents the critical mean radius at which colli-sion and coalescence begin. The observed cloud was also compared with a cloud simulation which had approximately the correct initial cloud-droplet concentration (N sub c). The simulated cloud base concentration (N sub c). The simulated cloud base was somewhat lower than observed, indicating that the initial sounding was too moist in the subcloud layer. As a result, the modeled could was wetter than observed. In spite of this variation from the observed cloud base, other properties were represented rather well by the simulated cloud, including cloud top height, peak vertical velocities, and the growth stages in the development of the storm. (Author's abstract)

CLOUD COVER ANALYSIS FROM SATELLITE IMAGERY USING SPATIAL AND TEMPORAL CHARACTERISTICS OF THE DATA, Centre National de la Recherche Scientifique, Pa-laiseau (France). Lab. de Meteorologie Dynami-

For primary bibliographic entry see Field 7B. W87-09704

VARIATIONS OF BAIU PRECIPITATION OVER JAPAN IN 1951-1980 AND LARGE-SCALE CHARACTERISTICS OF WET AND DRY BAIU,

Japan Meteorological Agency, Tokyo. Numerical Prediction Div. K. Ninomiya, and H. Mizuno.

Journal of the Meteorological Society of Japan JMSJAU, Vol. 65, No. 1, p 115-127, February 1987. 17 fig, 3 tab, 21 ref.

Descriptors: \*Baiu, \*Precipitation, \*Rainfall, \*Japan, Weather, Climate, Storms, Winds, Asia, Meteorology.

Variations of precipitation in June and July over Japan (Baiu precipitation) are studied for a 30-year period of 1951-1980 with special emphasize on the occurrence of wet (Iarge precipitation) and dry (small precipitation) Baiu season. Empirical Orthogonal Function (EOF) analysis is applied to monthly total precipitation (R), monthly total sunshine-duration (S), monthly mean surface temperature (T) in June and July In spite of precedic and ahine-duration (8), monthly mean surface tempera-ture (T) in June and July. In spite of sporadic and localized nature of Baiu precipitation, 50% of the R-variance is accounted by the 1st EOF compo-nent. The 1st spatial function (B sub 1 (x)) of R shows localized maximum value over southwestern shows localized maximum value over southwestern Japan while B sub 1 (2) of T shows localized maximum value over northeastern Japan. Any significant trend and periodic long-term variations are not seen in the 1st EOF's time variation function (A sub 1 (t)) of R. The relations among A sub 1 (t) fo R, S, T, and large-scale conditions in the East Asia are examined. A sub 1 (t) of R is positively correlated with anomaly of U- and V-component of 700 mb wind in the northern periphery of the Pacific anticyclone (Delta U sub 700 and Delta V sub 700 and negatively with A sub 1 (t) of T. Pacific anticyclone (Delta U sub 700 and Delta V sub 700) and negatively with A sub 1 (t) of T. While Delta U sub 700 is negatively correlated with A sub 1 (t) of T, the correlation between Delta V sub 700 and Delta U sub 700 and that between Delta U sub 700 and A sub 1 (t) of T are very small. From the analysis, following two independent large-scale conditions favorable for wet Baiu are pointed out; (1) positive Delta V sub 700, and (2) negative A sub 1 (t) of T (in many cases concurrent with positive Delta U sub 700, north-easterly flow from polar airmass to the north side easterly flow from polar airmass to the north side of Baiu front, development of Baiu ridge and trough). (Author's abstract) W87-09709

CASE STUDY OF A LONG-LIVED CLOUD

CASE STUDY CITY AND AN ACTUAL CLUSTER, Nagoya Univ. (Japan). Water Research Inst. K. Akaeda, K. Ninomiya, and T. Takeda. Journal of the Meteorological Society of Japan JMSJAU, Vol. 65, No. 1, p 129-144, February 1987. 20 fig, 1 tab, 22 ref.

Descriptors: \*Cyclones, \*Dynamic threshold method, \*Satellite imagery, \*Cloud size, \*Data interpretation, Estimating, Remote sensing, Convection, Japan, Weather.

A mesoscale cloud cluster was observed around a cyclone from the 7th to the 9th of October in 1983. Its synoptic situation, behavior and structure were studied using the data of satellites, radars, upper air sounding and rainfall amount. The cloud cluster sounding and rainfall amount. The cloud cluster formed in association with a cyclone which was found in the zone of large moisture gradient. It was initiated in the warm sector of the cyclone and then it approached to the warm front. The area of upward motion and convective instability, which were favorable for the development of convection, were localized in the limited region in the warm sector of the cyclone and the cluster was observed and the convention of the cyclone and the cluster was observed. sector of the cyclone and the cluster was observed near this region. In spite of the east-north-eastward movement of the cyclone, the cloud cluster stayed in the south of central part of Japan for more than 6 hours. Satellite IR data show that the evolution process of the cloud cluster was divided into two stages. In stage I the minimum equivalent blackbody brightness temperature (T sub BB) of this cloud cluster was less than -70 C. Its shape was oval. The maximum radii of cloud areas whose T sub BB were below -40 C and -60 C were about 170 km and 120 km, respectively. In this stage the cloud cluster existed mainly in the warm sector. In stage II the area of T sub BB lower than -60 C remained small. In contrast the area of T sub BB remained small. In contrast the area of T sub BB remained small. In contrast the area of T sub BB lower than -40 C increased again and it was elongated northeastward. Its width and length were 100 km and several-hundred kilometers, respectively. The cloud cluster consisted of the southwestern convective clouds, which were aligned northeastward, and the northeastern layer clouds which were composed of upper-level generating cells and middle-level clouds. In this stage the cloud cluster existed across the warm frontal region. Its northeastern part existed in the region

which is characterized by warm moist and stable air above the frontal layer and cold moist air under the frontal layer. There was localized area of convective instability above the frontal layer and this area would have been related to the formation of upper-level generating cells. (Author's abstract) W87-09710

MOISTURE BURSTS OVER THE TROPICAL PACIFIC OCEAN,
Texas A and M Univ., College Station.
J. P. McGuirk, A. H. Thompson, and N. R. Smith.
Monthly Weather Review MRWEAB, Vol. 115,
No. 4, p 78-798, April 1987. 9 fig. 15 ref. NASA
Contract NAS8-35182.

Descriptors: \*Moisture bursts, \*Dynamic threshold method, \*Satellite imagery, \*Cloud size, \*Data interpretation, Estimating, Remote sensing, Pacific Ocean, El Nino, Weather.

'Moisture bursts' are bands of high clouds or middle and high clouds extending poleward and eastward from deep tropical locations into subtropical and middle latitudes. These events, synoptic in both their synoptic scale and their tropical-extratropical interaction. We apply this definition to infrared satellite imagery for four 6-month cool seasons (November-April) in the eastern North Pacific (160 deg E to the west coast of the Americas). The frequency of these events is about ten bursts per month during normal cool seasons, distributed uniformly across the Pacific to the west of 110 deg W; east of this longitude, moisture bursts occur. Half of the bursts last 2 to 4 days, and no burst lasted longer than 10 days. Only 36 moisture bursts occurred during the 6-month El Nino cool season of 1982-83, with the location of occurrence shifted eastward. Few bursts occurred in the region of active tropical convection associated with the El Nino event. Because moisture burst frequency decreases at times when the ITCZ strengthens, we hypothesize two modes in Hadley cell behavior: a strong zonally symmetric mode, and a weaker mode comprised of the statistical ensemble of a large number of transient moisture bursts. Through analysis of wind fields, zonal averages across moisture bursts are shown to resemble transient intensification of the mean meridional circulation in regions where the Hadley cell is typically weak. (Author's abstract)

REMOTE CONTROL OF HYDROMETEORO-LOGICAL DEVICES, Utah Center for Water Resources Research,

For primary bibliographic entry see Field 7B. W87-09766

DATA ON SNOW CHEMISTRY OF THE CAS-CADE-SIERRA NEVADA MOUNTAINS, Geological Survey, Tacoma, WA. Water Re-For primary bibliographic entry see Field 2K. W87-09814

EMPIRICAL ANALYSIS OF PASSIVE MICRO-WAVE OBSERVATIONS FROM BHASKARA-II SAMIR AND REMOTE SENSING OF ATMOS-PHERIC WATER VAPOR AND LIQUID

WATER, Indian Space Research Organization, Ahmedabad. Space Applications Centre. For primary bibliographic entry see Field 7B. W87-09909

PREDICTABILITY OF JAVA MONSOON RAINFALL ANOMALIES: A CASE STUDY, Wisconsin Univ.-Madison. Dept. of Meteorology.

Wisconsin Univ.-Madison. Dept. of Meteorology. S. Hastenrath. Journal of Climate and Applied Meteorology JCAMEJ, Vol. 26, No. 1, p 133-141, January 1987. 5 fig. 3 tab, 28 ref. NSF Grant ATM84-13575.

Descriptors: \*Rainfall, \*Monsoons, \*Rainfall anomalies, \*Data interpretation, \*Java, Prediction, Atmospheric pressure, Australia, Darwin pressure, Seasonal variation, Pressure-rainfall relationships.

A substantial portion of the interannual variability of rainfall at Jakarta, Java, can be predicted from antecedent pressure anomalies at Darwin, northern Australia; the pressure persistence, the concurrent correlation of pressure and rainfall, and the predictability of rainfall from antecedent pressure are all largest during the 'east' monsoon (June-November). Because of the relatively simple large-scale circulation setting, warranting a single predictor (Darwin pressure), this region is chosen for a series of experiments aimed at exploring the seasonality and secular variations of predictability, optimal length of dependent record, and updating of the regression base period used for predictions on the independent data set. The major features of presure-rainfall relationships are common through much of the 1911-83 record, namely sign and general magnitude of correlations and the closer relationships during the east, as compared to the west, tionships during the east, as compared to the west, monsoon. Considerable differences are, however, apparent between decades. These may stem from both sampling deficiencies (noise) and real long-term changes of the pressure-rainfall couplings due to secular alterations in the large scale circulation to secular atterations in the large scale circulation setting. The competition between these two factors is relevant concerning the optimal length of the dependent record used for predictions into the independent data set, as well as the updating of the regression base period. (Author's abstract) W87-09912

REFLECTIVITY-RAIN RATE RELATION-SHIPS FOR RADAR HYDROLOGY IN BRAZIL,

Instituto de Pesquisas Espaciais, Sao Paulo For primary bibliographic entry see Field 7C. W87-09914

AREA-TIME-INTEGRAL TECHNIQUE TO ES-AREA-TIME-INTEGRAL TECHNIQUE TO ESTIMATE CONVECTIVE RAIN VOLUMES OVER AREAS APPLIED TO SATELLITE DATA - A PRELIMINARY INVESTIGATION, South Dakota School of Mines and Technology, Rapid City. Inst. of Atmospheric Sciences. For primary bibliographic entry see Field 7C. W37-09915.

SUPERCOOLED LIQUID WATER STRUCTURE OF A SHALLOW OROGRAPHIC CLOUD SYSTEM IN SOUTHERN UTAH, Colorado State Univ., Fort Collins. Dept. of At-

mospheric Science. R. M. Rauber, and L. O. Grant. Journal of Climate and Applied Meteorology JCAMEJ, Vol. 26, No. 1, p 208-215, January 1987.

Descriptors: \*Cloud liquid water, \*Clouds, \*Oro-graphic clouds, \*Cloud seeding, \*Water supply, \*Supercooling, Mountains, Orography, Utah, Pre-

A case study of an orographic cloud system that developed over the mountains of southern Utah is presented. The storm system contained supercooled liquid water over several hours, and pro-duced almost no precipitation. Because of the high duced almost no precipitation. Because of the high liquid water content, low ice particle concentrations, minimal precipitation, and a long duration, the storm appeared to be a good candidate for seeding to augment precipitation. A preliminary analysis of the climatological frequency of orographic cloud systems over these mountains is discussed. (Author's abstract)
W87-09916

METHODS FOR STUDY OF RAINDROP IMPACT ON PLANT SURFACES WITH APPLICATION TO PREDICTING INOCULUM DISPERSAL BY RAIN,
Ohio State Univ., Columbus. Dept. of Plant Pathology.

thology. nary bibliographic entry see Field 7B.

AROUND THE WORLD - WATER, WATER

#### Group 2B-Precipitation

National Environmental Satellite, Data, and Information Service, Washington, DC. D. Le Comte.

Veatherwise WTHWA2, Vol. 40, No. 1, p 9-10, February 1987.

Descriptors: \*Rainfall, \*Excess rainfall, \*Rainfall Descriptors: "Kannai, "Excess raintail, "Kannai distribution, "Precipitation, "Weather data collec-tions, "Data collections, Flood damage, Caribbean, Peru, Bolivia, United Kingdom, China, Philip-pines, Solomon Islands, Canada, Wheat.

Most places around the world seemed to have Most places around the world seemed to have sufficient or even too much rain in 1986. Excessive rainfall caused major flood damage in the Caribbe-an, Peru, and Bolivia, while storms resulted in the loss of life in the United Kingdom, China, the Philippines, and the Solomon Islands. Monthly rainfall was more than twice and as much as six times the normal in the Prairie Provinces of Canada and in Ontario hurting the quality but not decreasing the quantity of wheat. Drought did occur in some countries, but outside of southeast-ern IISA the damage was limited 1986 was noteoccur in some countries, but outside or southeast-ern USA, the damage was limited. 1986 was note-worthy for the lack of widespread drought, giving crop-producing countries a chance to restock food supplies and decreasing the number of countries reporting food shortages. (Wood-PTT) W87-09926

IN THE UNITED STATES - FLASH FLOODS AND DROUGHT.

National Environmental Satellite, Data, and Information Service, Washington, DC.
For primary bibliographic entry see Field 2E.
W87-09927

METEOSAT AND RADAR RAINFALL IMAGE-RY INTERPRETATION ON THE NIGHT OF 20/21 NOVEMBER 1986, Meteorological Office, Bracknell (England). For primary bibliographic entry see Field 7C. W87-09943

SATELLITE DERIVED TECHNIQUE FOR ES-TIMATING RAINFALL FROM THUNDER-STORMS AND HURRICANES,

National Environmental Satellite, Data, and Information Service, Washington, DC.
For primary bibliographic entry see Field 7B.
W87.09968

UTILIZING GOES IMAGERY TO DETERMINE CONVECTIVE STORM CHARACTERISTICS IN DATA DEFICIENT REGIONS,

Jolly (J.P.) and Associates, Ottawa (Ontario). For primary bibliographic entry see Field 7B. W87-09969

RAIN ESTIMATION OVER SEVERAL AREAS OF THE GLOBE USING SATELLITE IMAGE-

National Hurricane and Experimental Meteorology Lab., Coral Gables, FL. For primary bibliographic entry see Field 7B. W87-09970

SATELLITE RAINFALL ESTIMATION BY CLOUD INDEXING METHODS FOR DESERT LOCUST SURVEY AND CONTROL, Bristol Univ. (England). Dept. of Geography. For primary bibliographic entry see Field 7B. W87-09971

ESTIMATION OF RAIN RATE OVER LAND FROM SPACEBORNE PASSIVE MICROWAVE SENSORS.

ntal Research and Technology, Inc., Concord, MA. For primary bibliographic entry see Field 7B. W87-09972

DETERMINATION OF RAINFALL RATES FROM MEASUREMENTS OF THE SATEL-LITE NIMBUS 5 AND 6,

Cologne Univ. (Germany, F.R.). Inst. of Geophysics and Meteorology.
For primary bibliographic entry see Field 7B.

PRELIMINARY EVALUATION OF INITIAL ATMOSPHERIC MOISTURE FROM THE TIROS-N SOUNDING SYSTEM,

National Environmental Satellite, Data, and Information Service, Washington, DC.
For primary bibliographic entry see Field 7B.
W87-09974

STATISTICAL APPROACH TO RAINFALL ESTIMATION USING SATELLITE DATA,

TIMATION USING SATELLITE DATA, National Environmental Satellite, Data, and Information Service, Washington, DC. L. F. Whitney, and L. D. Herman. IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 139-143, 4 fig, 3 tab, 6 ref.

Descriptors: \*Meteorological data collection, \*Hydrologic data, \*Statistical analysis, \*Rainfall rate, \*Forecasting, \*Satellite technology, \*Remote sensing, Convective precipitation, Statistical studies, Hydrologic models, Rainfall intensity, Infrared imagery, Regression analysis.

A statistical approach is employed in an attempt to estimate convective rainfall using satellite data. The objective is to provide rainfall using satellite data. The objective is to provide rainfall estimates in a form suitable as input to hydrologic models which forecast river flow. These models require area-averaged rainfall over periods of 6 hours in watersheds covering 500 sq mi or more. Early in the study it was demonstrated that infrared temperatures alone are inadequate to estimate rainfall. A variety of additional variables derived from both satellite and conventional meteorological sources satellite and conventional meteorological sources were then included in the study. All variables were were then included in the study. All variables were thought to be physically or empirically related to the rainfall process. From among these variables, a screening regression method selected those which best explain area-averaged rainfall. In both cases studied thus far, the selected variables correlated with rainfall at above 0.8. But since meteorological with rainfall at above 0.8. But since meteorological conditions in each case were very different, neither regression equation was a good estimator of the rainfall in the other case. Some of the most important variables selected were IR-temperature gradients along the tropospheric shear, ratio of IR-temperature to IR-temperature gradient along the low-level wind, low-level dewpoint advection. Although these preliminary results are encouraging, many more cases must be included and any positive results checked against independent data. (See also W87-09953) (Author's abstract) W87-09976 W87-09976

EFFECTS OF 'PRISTINE' AND 'INDUSTRIAL' SIMULATED ACIDIC PRECIPITATION ON GREENHOUSE-GROWN RADISHES, Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Plant Pathology and Physiology. For primary bibliographic entry see Field 5C. W87-10085

#### 2C. Snow, Ice, and Frost

NUMERICAL MODELING OF HAILSTORMS NUMERICAL MODELING OF HAILSTORMS AND HAILSTONE GROWTH. PART II: THE ROLE OF LOW-DENSITY RIMING GROWTH IN HAIL PRODUCTION, South Dakota School of Mines and Technology, Rapid City. Inst. of Atmospheric Sciences. For primary bibliographic entry see Field 2B. W87-09702

COMPARISON OF NORTHERN HEMI-SPHERE SNOW COVER DATA SETS, Maryland Univ., College Park. Dept. of Meteorol-

For primary bibliographic entry see Field 7C.

SNOWFALL - BELOW AVERAGE.

D. M. Ludlum. Weatherwise WTHWA2, Vol. 40, No. 1, p 41-44,

Descriptors: \*Snow, \*Snow accumulation, \*Snow depth, \*Weather data collections, \*Data collections, Ice storms, United States, Drought, Snow

Snowfall amounts were reported for various parts of the USA for each month from September 1985 through June 1986. The nationwide dry spell in December and January caused the snowfall totals to be lower than usual, particularly in the Pacific Northwest. In the western part of the country snowfall was excessive in November and April but snowfall was excessive in November and April but light during the midwinter. No traditional north-easterns developed along the Atlantic seaboard during the winter 1985-6, so total snowfall was low, though several unusual spring snowstorms and ice storms were reported. (Wood-PTT) W87-09928

SATELLITE SNOW MAPPING TECHNIQUES WITH EMPHASIS ON THE USE OF LAND-

ental Research and Technology, Inc., Environ Concord, MA For primary bibliographic entry see Field 7B. W87-09978

APPLICATION OF SNOW COVERED AREA TO RUNOFF FORECASTING IN THE SIERRA NEVADA, CALIFORNIA, Sierra Hydrotech, Placerville, CA. J. F. Hannaford, and A. J. Brown. In: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 165-172, 4 fig, 4 ref.

Descriptors: \*Runoff forecasting, \*Snow cover, \*Hydrologic data, \*Sierra Nevada, \*California, \*Satellite technology, \*Remote sensing, Forecasting, Snowmelt, Snowpack, Model studies, Simulation analysis, Data acquisition, Hydrologic models.

tion analysis, Data acquisition, Hydrologic models.

The National Aeronautics and Space Administration has sponsored a four year research project to explore the application of snow covered area (SCA) obtained from satellite imagery to hydrologic forecasting within an operational time frame. California was one of the four test areas where NASA conducted Applications Systems Verification and Transfer (ASVT) projects on the use of SCA in operational hydrologic forecasting. California's southern Sierra Nevada provided test watersheds where snowpack accumulates during the winter months and melts during the spring and summer (April through July). Operational forecasting is required at two different levels. First, estimates of the total volume of spring snow melt with timely updates related to observed conditions during the melt season are required for operational planning. Second, simulation of the rate of snow melt runoff utilizing hydrologic models also provides a valuable operational tool when the time distribution of runoff is critical to project operation. This paper describes research related to interpretation of satellite imagery to obtain SCA on a near real-time basis, and to test the utilization of SCA operationally in volumetric water supply forecasting and hydrologic modeling. (See also W87-09979)

SATELLITE IMAGE ATLAS OF THE EARTH'S

GLACIERS, Geological Survey, Reston, VA. For primary bibliographic entry see Field 7B. W87-09980

SATELLITE RECORD OF THE WINTER OF 1978-79 IN NORTH AMERICA,

National Environmental Satellite, Data, and Information Service, Washington, DC.
For primary bibliographic entry see Field 7B.
W87-09981

#### Streamflow and Runoff-Group 2E

W87-09610

POTENTIALS OF MAPPING BURIED GLA-CIER ICE WITH LANDSAT THERMAL IM-AGERY,

State Univ. of New York Coll. at Geneseo. Dept. of Geography.

or Ucegraphy.

R. Lougeay.

IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 189-192, 4 fig, 5 ref.

Descriptors: \*Glaciers, \*Ice, \*LANDSAT, \*Hydrologic data, \*Remote sensing, \*Mapping, Maps, Satellite technology, Radiometry, Glaciology, Ice

Field observations and analysis of LANDSAT imagery for the Wrangell Mountains of Alaska reveal information concerning the nature and extent of buried glacier ice. Hundreds of square kilometers of active moraine covered glacier ice exist within this region. Spectral bands 5, 7, and false color composite imagery from existing Landsat multispectral data proved most useful to interpreters mapping glacial margins and large masses of active, but buried, glacier ice. Signal contrasts between bare detritus and vegetation cover were most strongly pronounced on band 5, while band 7 displayed stronger contrasts between the microtopographic texture of the moraine covered ice masses and adjacent detrital surfaces of talus or outwash. Radiometric data from airborne overlights were used to prepare thermal emittance maps of the study area. Information from these simulations of Landsat thermal imagery, having a spatial and thermal resolution similar to the thermal image specifications of MSS band 8 aboard LANDSAT-3 (10.4-12.6 micron), has served to augment the information available from the visible and near visible Landsat imagery. When the mantle of morainic detritus is thinner than the diurnal thermal damping depth, strong signal contrasts between ice cored moraines and dry glacial drift deposits are present. In addition, simulations of LANDSAT-3 thermal imagery display strong contrasts between areas of relatively different surface flow activity within the mass of buried ice. (See also W87-09982) Field observations and analysis of LANDSAT imagery for the Wrangell Mountains of Alaska reveal information concerning the nature and extent of W87-09982

PREDICTION OF WATER YIELD USING SAT-ELLITE IMAGERY AND A SNOWMELT SIMU-LATION MODEL,

Arizona Univ., Tucson. School of Renewable Natural Resources

For primary bibliographic entry see Field 7B. W87-09983

ICEBERG DETECTABILITY
USING SAR AND SLAR SYSTEMS. PROBLEMS INTERA Environmental Consultants Ltd., Ottawa (Ontario). For primary bibliographic entry see Field 7B. W87-09984

PASSIVE MICROWAVE SENSING OF SNOW CHARACTERISTICS OVER LAND.

National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. For primary bibliographic entry see Field 7B. W87-09985

LANDSAT DERIVED SNOW COVER AS AN INPUT VARIABLE FOR SNOW MELT RUNOFF FORECASTING IN SOUTH CENTRAL COLORADO,

Soil Conservation Service, Denver, CO. Snow Survey Unit. For primary bibliographic entry see Field 7B. W87-09986

MONITORING SNOW WITH MICROWAVES, Kansas Univ./Center for Research, Inc., Law rence. Remote Sensing Lab. For primary bibliographic entry see Field 7B. W87-09987

OPERATIONAL USE OF SATELLITE DATA FOR SNOW INVENTORY AND RUNOFF

FOR SNOW INVENTORY AND RUN FORECAST, Norges Vassdrags- og Elektrisitetsvesen, Oslo For primary bibliographic entry see Field 7B. W87-09988

#### 2D. Evaporation and Transpiration

MEASUREMENT OF IRRIGATION EVAPORA-TIVE LOSSES BY A NEW VAPOR BUDGET Clemson Univ., SC. Dept. of Civil Engineering. For primary bibliographic entry see Field 7B. W87-09785 TECHNIQUE,

CLIMATIC DATA FOR MIRROR LAKE, WEST THORNTON, NEW HAMPSHIRE, 1981-1982, Geological Survey, Lakewood, CO. Water Re-For primary bibliographic entry see Field 2H. W87-09806

CONCERNING THE RELATIONSHIP BE-TWEEN EVAPOTRANSPIRATION AND SOIL

MOISTURE, National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. P. J. Wetzel, and J.-T. Chang. Journal of Climare and Applied Meteorology JCAMEJ, Vol. 26, No. 1, p 18-27, January 1987. 5 fig, 2 tab, 49 ref, append.

Descriptors: \*Evapotranspiration-soil water rela-tionships, \*Evapotranspiration, \*Soil water, \*Mathematical equations, Mathematical studies, Threshold evapotranspiration, Soil moisture reten-tion, Model studies, Vegetation effects, Remote sensing, Numerical models.

sensing, Numerical models.

Evapotranspiration observations have traditionally been scaled by potential evapotranspiration as a means of unifying the soil moisture-evapotranspiration relationship under a variety of meteorological conditions. However, this scaling alone does not unify the relationship during the drying, supply-limited phase. A second scaling parameter is identified which applies to this phase of evapotranspiration. The parameter is a maximum sustainable, or threshold evapotranspiration, which occurs in vegetation-covered surfaces just before leaf stomata close, and occurs when surface tension begins to significantly restrict the moisture release from bare soil pores. Simple expressions for this parameter are presented for the cases of vegetation cover and bare soil. The number of input variables required in these expressions is rather small. The effect of natural soil heterogeneities on evapotranspiration as computed from the proposed model were examined. It is shown that the observed natural variability in soil moisture resulting from these heterogeneities is large enough to seriously alter the relationship between regional evapotranspiration and the area average soil moisture when compared to the point, or homogeneous relationship. The implications for remote sensing and grid point numerical models are discussed. As a consequence of these results, some key elements of a very simple parameterization for regional evapotranspiration. car models are discussed. As a consequence of these results, some key elements of a very simple parameterization for regional evapotranspiration were proposed for use in numerical models. (Au-thor's abstract) W87-09910

OPTICAL AND DIGITAL ANALYSES OF LANDSAT DATA DEPICTING HYDROGEOLO-LANDSAT DATA DEPICTING HYDROGEOLO-GICAL FEATURES OF THE DARYACHEH-YE-NAMAK AREA, IRAN, Nova Scotia Land Survey Inst., Lawrencetown. For primary bibliographic entry see Field 7B. W87-09993

#### 2E. Streamflow and Runoff

SCALE PROBLEMS IN HYDROLOGY: RUNOFF GENERATION AND BASIN RE-SPONSE. HYDROLOGY: For primary bibliographic entry see Field 2A.

RELATIVE ROLE OF HILLSLOPE AND NET-WORK GEOMETRY IN HYDROLOGIC RE-SPONSE

Mississippi Univ., University. Dept. of Civil Engineering. For primary bibliographic entry see Field 2A. W87-09611

NONLINEARITY AND TIME-VARIANCE OF THE HYDROLOGIC RESPONSE OF A SMALL

MOUNTAIN CREEK,
Consiglio Nazionale delle Ricerche, Turin (Italy).

Ist. di Ricerca per la Protezione Idrogeologica nel Bacino Padano For primary bibliographic entry see Field 2A. W87-09612

RUNOFF SIMULATION MODEL BASED ON HILLSLOPE TOPOGRAPHY, Leeds Univ. (England). School of Geography. For primary bibliographic entry see Field 2A. W87-09613.

GEOMORPHOLOGIC APPROACH TO SYNTHESIS OF DIRECT RUNOFF HYDROGRAPH FROM THE UPPER TIBER RIVER BASIN,

TRUM THE UPPER TIBER RIVER BASIN, ITALY, Consiglio Nazionale delle Ricerche, Perugia (Italy). Ist. di Ricerca per la Protezione Idrogeologica nell' Italia Centrale. For primary bibliographic entry see Field 2A. W87-09614.

RUNOFF PRODUCTION AND FLOOD FRE-QUENCY IN CATCHMENTS OF ORDER N: AN ALTERNATIVE APPROACH, Lancaster Univ. (England). Dept. of Environmen-For primary bibliographic entry see Field 2A. W87-09616

STUDY OF SCALE EFFECTS IN FLOOD FRE-QUENCY RESPONSE, University Coll., Galway (Ireland). Dept. of Engineering Hydrology. For primary bibliographic entry see Field 2A. W87-09617

SCALES, GRAVITY AND NETWORK STRUC-TURE IN BASIN RUNOFF, Mississippi Univ., University. Dept. of Civil Engi-For primary bibliographic entry see Field 2A. W87-09618

AVERAGING PROPERTIES OF CHANNEL NETWORKS USING METHODS IN STOCHASTIC BRANCHING THEORY,

IIC BRANCHING THEORY,
Geological Survey, Denver, CO.
B. M. Troutman, and M. R. Karlinger.
IN: Scale Problems in Hydrology: Runoff Generation and Basin Response, D. Reidel Publishing Co.,
Dordrecht, Holland. 1986. p 185-216, 2 fig. 2 tab.

Descriptors: \*Geomorphology, \*Unit hydro-graphs, \*Channel flow, \*Hydrologic properties, \*Stochastic hydrology, Mathematical analysis, Sta-tistical analysis, Hydraulic properties, Statistical analysis, Topology, Probability distribution, Simu-lation analysis, Statistical studies, Routing.

Methods in branching theory are used to average properties of channel networks, resulting in expres-sions for the instantaneous unit hydrograph (IUH) in terms of fundamental network characteristics in terms of tundamental network characteristics (zeta, alpha, beta), where alpha parameterizes the link (channel segment) length distribution and beta is a vector of hydraulic parameters. Several possibilities for zeta are considered, including N, (N, D), (N, M), D', and (N, D'), where N is magnitude (number of first-order streams). D is topological diameter, M is order, and D' is mainstream length.

#### Group 2E-Streamflow and Runoff

Linear routing schemes, including translation, dif-fusion, and general linear routing, are used, and it is demonstrated that translations routing leads to an IUH identical to that obtained by use of the an IUH identical to that obtained by use of the width function, where for a given distance x, the width of a network is defined to be the number of links some point of which lies at channel distance x from the outlet (analogous to population size in branching theory). The IUH is taken to be the conditional expectation of actual basin response given zeta, and it is derived based on assumptions that the links are independent and identically disthat the links are independent and identically dis-tributed random variables and that the network is a tributed random variables and that the network is a member of a topologically random population. Uncertainty in use of this expectation to approximate actual basin response is given by the corresponding conditional variance. Asymptotic (for large N, D, and D') results are available for several cases. For example, when zeta = N asymptotic considerations lead to a Weibull probability density function for the IUH for all linear routing schemes, with only a single parameter depending on the particular routing method. A simulation study compares different possibilities for zeta in terms of ability to predict actual IUH characteristics. These characteristics include neak and time to peak. (See characteristics include peak and time to peak. (See also W87-09536) (Author's abstract)

INCORPORATION OF CHANNEL LOSSES IN THE GEOMORPHOLOGIC IUH,
Massachusetts Inst. of Tech., Cambridge. Dept. of

Civil Engineering.
For primary bibliographic entry see Field 2A.
W87-09620

MICROCOMPUTER-BASED FLUOROMETRIC DATA LOGGING SYSTEM FOR FLOW AND DISPERSION MEASUREMENTS,

University of Strathclyde, Glasgow (Scotland). Dept. of Physics. For primary bibliographic entry see Field 7C. W87-09706

INSTANTANEOUS UNIT HYDROGRAPHS: A GEOMORPHOLOGIC APPROACH, Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 4A.
W87-09777

DEVELOPMENT OF CONFIDENCE INTER-VALS AND MONTHLY DESIGN VALUES FOR LOW STREAMFLOWS,
Georgia Univ., Athens. Dept. of Statistics and

ter Science

Computer Science.
W. P. McCormick, and J. H. Reeves.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB87-179529/
AS. Price codes: A04 in paper copy, A01 in microfiche. Environmental Resources Center, Georgia
Institute of Technology, Atlanta. Report No. ERC
05-86, July 1986. 66p, 6 tab, 30 ref. Contract No.
14-08-0001-G-1011. USGS Project No. G1011-05.

Descriptors: \*Low flow frequency, \*Design flow, \*Time series analysis, \*Streamflow forecasting, Estimation procedures, Monthly distribution.

Analyses were done on three problems related to a design low flow called the 'seven day, ten year minimum streamflow' (7Q10). The 7Q10 denotes the tenth percentile of the distribution of the streamflow, which gives for a one year period the lowest level of streamflow for which there was a streamflow. seven consecutive day period with flows below that value on each day. The 7Q10 is commonly that value on each day. The 7010 is commonly used as an annual design low streamflow for determining wastewater discharge permit specifications. The first problem is to determine monthly design low streamflow values. A method of assigning design low flow values which can vary over the year is of interest in order to allow greater use of the stream for diluting wastewater discharges. A simple method is offered for calculating monthly design low flow values, which does not lead to any greater number of daily contraventions below the monthly design flows than that which already monthly design flows than that which already occurs for the one fixed annual 7Q10 method. The

second problem concerns the estimation of 7O10 with a confidence interval. A method based on a model for daily streamflows is offered, and a new their used procedures. The third problem concerns the estimation of 7010 when the record of streamflow is only partial and short. A procedure is recommended which incorporates the use of rainfall data into our estimation procedure for 7Q10. (McCormick-Univ of Georgia) estimation procedure is compared with two other often used procedures. The third problem concerns

SLACK-WATER DEPOSITS AND THE MAGNITUDE AND FREQUENCY OF FLASH FLOODS, EASTERN KENTUCKY, Kentucky Water Resources Research Inst., Lex-

ington. R. G. Shepherd, and L. K. Bienkowski

Available from the National Technical Information Service, Springfield, VA 22161, as PB87-159380/ AS. Price codes: A03 in paper copy, A01 in micro-fiche. Report No. 167, Nov. 1986, 38 p, 10 fig. 2 tab 65 ref. Contract No. 14-08-0001-G1019. USGS Project No. G1019-06.

Descriptors: \*Flash floods, \*Flood forecasting, Sediment-water interfaces, Flood peak, Kentucky.

The potential for predicting flood magnitude and frequency using sediments deposited in backwater areas during flash floods was investigated on the Cumberland Plateau of Eastern Kentucky, a region notorious for flash flooding. Slack-water deposits are abundant in the area at tributary mouths and bedrock channel expansions. They are identifiable on geologic quadrangle maps, and are locally good potential indicators of maximum flood crest elevations. However, in this humid region, flash floods could not be distinguished from non-flash floods using slack-water sedimentology. The results from slack-water deposits studied indicated that they offer limited potential for predicting flash floods offer limited potential for predicting flash floods because: (1) intense weathering, erosion, and biturbation of slack-water deposits has rapidly altered and generally destroyed the flood stratigraphy to the extent that flood frequency data could not be obtained; (2) mineralogic differences of bedrock units in tributaries of drainages prone to flash flooding are small and inadequate for distinguishing tributary and main channel flood deposits; and ing tributary and main channel flood deposits; and (3) flash floods in tributaries commonly but not always cause backwaters and slack-water deposits in main channels, preventing use of the conventional slope-area method of estimating discharge. The results suggest that the slack-water method may be successful if first a quantitatively comprehensive method of describing flash floods using meteorologic, hydrologic, geomorphic, and sedimethod of describing flash floods using meteorologic, hydrologic, geomorphic, and sedimentologic parameters could be developed and used to distinguish them from non-flash floods. (Huffsey-KWRRI)

COMPARISON OF UNREGULATED AND REGULATED STREAMFLOW FOR THE YAKIMA RIVER AT UNION GAP AND NEAR

PARKER, Geological Survey, Tacoma, WA. Water Re-

J. J. Vaccaro. Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 82-646, 1986. 54 p, 11 fig. 18 tab, 4 ref.

Descriptors: "Streamflow, "River regulation, "Reservoir storage, "Yakima River, "Washington, Natural flow, Regulated flow, Surface irrigation, Return flow, Mathematical models, Storage equation, Simulation, Error analysis, Statistical analysis, Union Gap, Parker.

Records of regulated daily mean discharge for 52 water years, 1926-77, at 13 stream gaging stations were adjusted for changes in storage contents in five reservoirs and flows diverted in 58 canals to estimate effects of reservoir storage and canal di-version on streamflow in the Yakima River at Union Gap and near Parker, Washington. Estimat-ed composite error of computed unregulated dis-charges, based on analyses of several possible sources of error, was 10 percent. Unregulated

streamflow at Union Gap and near Parker was streaminow at Omon Cap and near Farker was shown to be basically equivalent. Regulation re-duced unregulated 52-year mean annual discharge from 5,900 cu ft/sec to 3,800 cu ft/sec at Union Gap and 2,300 cu ft/sec near Parker. Losses were due primarily to diversion for agricultural irriga-tion and to export of water from Upper to Lower Takima basin. Regulation reduced springtime high flows and increased August-September low flows at Union Gap, but three canals between Union Gap and Parker caused flow in the Yakima River to diminish to very low values. Coefficients of varia-tion and distribution percentiles of mean discharges indicate that the relative variability of regulated means has generally decreased compared with unregulated means at Union Gap and increased compared with unregulated flow near Parker. (USGS) W87-09811

SOURCES OF CLIMATOLOGIC, HYDROLOGIC, AND HYDRAULIC INFORMATION IN THE ILLINOIS RIVER BASIN, Geological Survey, Urbana, IL. Water Resources

For primary bibliographic entry see Field 10C. W87-09813

RIVER-QUALITY ASSESSMENT OF THE TRUCKEE AND CARSON RIVER SYSTEM, CALIFORNIA AND NEVADA – HYDROLOGIC CHARACTERISTICS,
Geological Survey, Sacramento, CA. Water Re-

For primary bibliographic entry see Field 6G. W87-09816

HYDROLOGIC DATA FOR THE SOUTH-CENTRAL AREA, NEBRASKA, Geological Survey, Lincoln, NE. Water Resources

DIV.
P. A. Bartz, and J. M. Peckenpaugh.
Available from USGS, OFSS, Box 25425, Denver,
CO 80225. USGS Open File Report 86-246, 1986.
78 p, 8 fig, 15 tab, 15 ref.

Descriptors: \*Hydrologic data, \*Water resources data, \*Groundwater, \*Surface waters, \*Nebraska, Data collections, Water use data.

Hydrologic data were compiled for the South-Central hydrogeology study, which covers an area of approximately 5,600 square miles in south-central Nebraska. Data pertain to the groundwater, surface water, climate, land use, and pumpage and surface water, climate, land use, and pumpage and precipitation at water use sites in the study area. Groundwater data include water level elevations from three mass measurements of wells and water quality information from 68 water quality sampling sites. Surface water data include average annual stream flows and average October through December streamflows at U.S. Geological Survey gaging stations, canal diversions, and seepage from canals and reservoirs. Climatic data include monthly precipitation records for eight weather stations and evaporation data from four reservoirs. Land use data were compiled for agricultural land uses, by county, from 1940 through 1981. Water use site data include water levels at each of 18 sites, soil information for those sites with complete precipita-information for those sites with complete precipitadata include water levels at each of 15 sites, soil information for those sites with complete precipitation and pumpage records, and precipitation and groundwater pumpage information for each site. (USGS)
W87-09818

PHYSICAL AND CHEMICAL DATA FOR THE SACRAMENTO RIVER AT RIO VISTA, CALI-FORNIA, JANUARY THROUGH MAY, 1983, Geological Survey, Menlo Park, CA. Water Resources Div.

For primary bibliographic entry see Field 5B. W87-09819

SUMMARY OF WATER RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN

FISCAL YEAR 1986, Geological Survey, Lakewood, CO. Water Resources Div For primary bibliographic entry see Field 2F.

W87-09821

ACTIVITIES OF THE WATER RESOURCES DIVISION, CALIFORNIA DISTRICT, IN THE 1985 FISCAL YEAR,

Geological Survey, Sacramento, CA. Water Re-

Sources Drv.
P. W. Anttila.
Available from USGS, OFSS, Box 25425, Denver,
CO 80225. USGS Open File Report 86-244, 1986. 90 p, 7 fig, 5 ref.

Descriptors: \*Groundwater resources, \*Hydrologic studies, \*California, Floods, Mudflows, Hazards, Wastewater reuse, Water quality.

wastewater reuse, water quality.

This report summarizes the progress of water-resources studies in California by the U.S. Geological Survey during the fiscal year 1985. Much of the work was done in cooperation with the State and local agencies. Additional supporting funds were transferred from other Federal agencies or appropriated directly to the Geological Survey. The water-resources program in California consisted of 5p projects. This report includes a brief discussion of each project and also contains a brief description of the origin of the U.S. Geological Survey, the Water Resources Division's basic mission, and abbreviated organizational structure of the California District, sources of funding, and a summary of water conditions. Reports issued by the Geological Survey on studies completed fiscal years 1984 and 1985 also are listed. (USGS)

BACKGROUND HYDROLOGIC INFORMA-TION IN POTENTIAL LIGNITE MINING AREAS IN MISSISSIPPI, AUGUST 1985, Geological Survey, Jackson, MS. Water Resources

For primary bibliographic entry see Field 5B. W87-09831

SIAGE-DISCHARGE RELATIONS FOR BLACK WARRIOR RIVER AT WARRIOR DAM NEAR EUTAW, ALABAMA-UPDATED 1985, Geological Survey, Montgomery, AL. Water Re-sources Div.

sources Div. G. H. Nelson, and C. O. Ming. Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 85-698, 1986. 7 p, 2 fig, 1 tab, 3 ref.

Descriptors: \*Stage-discharge relations, \*Rating curves, \*Control structures, \*Backwater gates, \*Black Warrior River, \*Warrior Dam, \*Alabama, Tailwater, Greene County.

The construction of Warrior Dam, completed in 1962, has resulted in changes to the stage-discharge relations in the vicinity. The scarcity of current-meter measurements, coupled with backwater conditions, make definition of a single stage-discharge relation impossible without considerable error. However, as a useful alternative, limit curves were riowever, as a useful atternance, limit curves were developed in 1983 that defined the limits of possible stage-discharge relations at the dam tailwater section. Since the 1983 report, 37 discharge values computed through the dam for the flood of December 1983 were used to verify or update the lower end of the limit curves. Data obtained from sower end or the limit curves. Data obtained from a current-meter measurement of the February 1961 flood (furnished by the U.S. Army Corps of Engi-neers) were used to update the upper end of the curves. This report presents the updated informa-tion. (USGS) W87-09846

HYDROLOGIC DATA FOR THE SOUTHERN SAND HILLS AREA, NEBRASKA, Geological Survey, Lincoln, NE. Water Resources

Div. M. S. Johnson, J. W. Goeke, and R. A. Engberg. Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 86-411, 1986.

136 p, 7 fig, 3 tab

Descriptors: \*Nebraska, \*Hydrologic data, \*Data collections, Southern Sand Hills Area, Water resources data, Groundwater data, Streamflow data.

This report presents hydrologic data used in the Southern Sand Hills hydrogeology study, which encompasses an area of approximately 4,330 square miles in west-central Nebraska. These data include summary logs of 64 test holes drilled in or adjacent to the study area. Water level data for 240 wells are included. These wells were measured in spring and fall of 1982 and spring of 1983. Water quality samples were collected from 62 irrigation wells. Water quality data include analyses for 18 routine constituents on samples from all wells and analyses for 8 trace constituents on samples from 25 wells. Rainfall data were collected at 30 sites by local observers from April 1982 to October 1983. Surface water data for 103 stream sites in the study area are included. Water discharge was measured at these sites as part of seepage surveys conducted from 1978 to 1982 to determine where and how much streams were gaining or losing water. (USGS) (USGS) W87-09847

WATER RESOURCES OF LAKE AND MOODY

COUNTIES, SOUTH DAKOTA,
Geological Survey, Houston, TX. Water Re-

Geological Survey, Houston, TX. Water Resources Div.
D. S. Hansen.
Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 84-4209, 1986. 51 p, 28 fig, 7 tab, 24 ref.

Descriptors: \*Water resources data, \*Data collections, \*Hydrologic data, \*Aquifers, \*South Dakota, Water wells, Water quality, Water use, Lake County, Moody County, Geohydrology.

Lake County, Moody County, Geohydrology.

The primary sources of surface water in Lake and Moody Counties are the Big Sioux River and its intermittent tributaries, and Lakes Herman, Madison, and Brant. Seasonal variations in streamflow and lake levels are directly related to seasonal variations in precipitation. Dissolved-solids concentration in water from streams and lakes increases as streamflow decreases and lake levels decline. Eight glacial aquifers and four bedrock aquifers were delineated in Lake and Moody Counties. The Big Sioux, North Skunk Creek, Petestone Creek, Battle Creek, and East Fork Vermillion aquifers are composed of glacial outwash. These aquifers are less than 60 feet below land surface, and are in hydraulic connection with the river or creek of the same name. The Rutland, Ramona, and Howard aquifers are tomposed of glacial outwash and are overlain by 50 to 470 feet of till. The four bedrock aquifers are the Niobrara, Codell, Dakota, and Quartzite wash. The average thickness of the Big Sioux, Pipestone Creek, North Skunk Creek, Battle Creek, and East Fork Vermillion aquifers ranges from 14 feet for the Battle Creek aquifer to 39 feet for the North Skunk Creek aquifer. The average thickness of the Rutland, Ramona, and Howard aquifers arges from 18 feet for the Ramona aquifer to 40 feet for the Howard aquifer. Predominant chemical constituents in water from the Big Sioux, North Skunk Creek, and Pipestone Creek aquifers are calcium and sulfate. Predominant chemical constituents in water from the Rutland, Ramona, and Howard aquifers ranges from 60 to 400 feet. The aquifers are calcium, sulfate and biocarbonate. The average thickness of the four bedrock aquifers arges from 60 to 400 feet. The aquifers are under artesian conditions. Predominant chemical constituents in water from the Niobrara aquifer are calcium, sulfate and biocarbonate. The average thickness of the four bedrock aquifers are are solium, sulfate and biocarbonate. The average thickness of the four bedrock aquifers are solium, sulf The primary sources of surface water in Lake and cal constituents in water from the Niobrara aquifer are calcium, sodium, and sulfate; from the Codell and Dakota aquifers are sodium and sulfate; and from the Quartzite wash aquifer are calcium, sulfate, and bicarbonate. Water use in 1980 in Lake and Moody Counties was about 2.6 billion gallons. Ninety percent of the water used in the counties was withdrawn from the glacial aquifers and 10 percent was withdrawn from the bedrock aquifers. (USGS) W87-09849

WATER RESOURCES OF THE SOUTHEAST

Geological Survey, Rolla, MO. Water Resources

R. R. Luckey, and D. L. Fuller.

#### Streamflow and Runoff-Group 2E

Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 84-4277, 1985. 78 p, 36 fig, 7 tab, 28 ref.

Descriptors: \*Water resources, \*Missouri, Surface waters, Groundwater, Aquifers, Irrigation water, Municipal waters.

Municipal waters.

The Southeast Lowlands of Missouri occupies 4,000 square miles of prime agricultural land of the Coastal Plain in the extreme southeastern corner of Missouri. Even though this area receives about 4 feet of rainfall per year, there is a rapidly increasing demand for water for irrigation. The purpose of this study was to evaluate the water resources of this area with particular emphasis on the extent of irrigation and the potential of the groundwater system to support further irrigation development. The area is underlain by consolidated aquifers of Paleozoic age and unconsolidated aquifers of Mesozoic and Cenozoic age. The consolidated aquifers shalthough possessing the potential to yield large quantities of water, generally are not used throughout much of the area because they lie at considerable death and alternate supplies are readily available. The McNairy aquifer, which underlies about three-fourths of the area, ranges from 0 to 600 feet in thickness with the top lying from 0 to more than 2,200 feet below land surface. This system is attractive as a municipal water supply because of its in thickness with the top lying from 0 to more than 2,200 feet below land surface. This system is attractive as a municipal water supply because of its large artesian head and the small iron and hardness concentrations of the water. Although this system is now used exclusively for municipal water supplies, the McNairy may become more important in the future as a heat source. The Wilcox Group (undivided), which underlies more than one-half of the area and almost always lies less than 300 feet below land surface, is as much as 1,400 feet thick. However, usually only the basal 250 to 500 feet of this group is used as an aquifer. This system, which in some areas is capable of yielding as much as 1,500 gallons per minute to properly constructed wells, is now primarily used for municipal supplies. The alluvial aquifer underlies most of the area and is locally capable of yielding more than 3,000 gallons per minute. This aquifer generally is 100 to 200 feet thick, but in several places more than 250 feet of alluvium has been reported. Irrigation wells withdraw an estimated 95,000 acre-feet per year from this aquifer, whereas municipal, industrial, and domestic wells withdraw an estimated additional 17,000 acre-feet per year. This compares to nearly 6 million acre-feet per year natural discharge and a total storage of 60 million acre-feet. The surface-water system in the area consists of a few natural rivers and many mammade ditches. Although a considerable quantity of water is available from the surface-water system, this system is not extensively used because attractive alternative able from the surface-water system, this system is not extensively used because attractive alternative sources are readily available. (USGS) W37-09855

ASSESSMENT OF LOW-FLOW WATER QUALITY IN THE DU PAGE RIVER, ILLINOIS, Geological Survey, Urbana, IL. Water Resources For primary bibliographic entry see Field 5B. W87-09860

SUMMARY OF HYDROLOGIC INFORMA-TION FOR THE DENVER COAL REGION, COLORADO,

Geological Survey, Lakewood, CO. Water Resources Div. For primary bibliographic entry see Field 7C. W87-09866

ESTIMATION OF NATURAL STREAMFLOW CHARACTERISTICS IN WESTERN COLORA-

DO, Geological Survey, Lakewood, CO. Water Resources Div.

sources Div.

J. E. Kircher, A. F. Choquette, and B. D. Richter.

Available from USGS, OFSS, Box 25425, Denver,

CO 80225, USGS Water-Resources Investigations

Report 85-4086, 1985, 28 p, 4 fig, 8 tab, 33 ref.

Descriptors: \*Streamflow, \*Regional analysis, \*Colorado, Regional floods, Regression analysis, Natural flow, High flow, Low flow, Peak dis-

#### Group 2E-Streamflow and Runoff

charge, Regionalization, Mean annual discharge, Mean monthly discharge, Peak discharge.

Regression relations were determined for estimat-Regression relations were determined to resumar-ing mean annual discharge, mean monthly dis-charge, minimum and maximum 7-day discharge, flow duration series, and peak discharge for natural streams in western Colorado. Multiple regression analyses were used to determine the best predictive relations for each of the streamflow characteristic; separate relations were developed for each of four hydrologically distinct regions in the study area. The standard errors associated with the The standard errors associated with the regression relations generally were less than 100 percent, relations generally were less than 100 percent, except for the low-flow relations which had stand-ard errors ranging from 62 to greeter than 200 percent. Basin drainage area, mean annual precipi-tation, mean basin elevation, and mean basin slope are used in the regression relations to estimate the flow characteristics of streams in the study area. (USGS) W87-09867

STOCHASTIC MODEL FOR THE STUDY OF THE DRAINAGE DENSITY IN THE UPPER BASIN OF THE DARRO RIVER (GRANADA) (UN MODELO ESTOCASTICO PARA EL ES-TUDIO DE LA DENSIDAD DE DRENAJE DE LA CUENCA SUPERIOR DEL RIO DARRO (GRANADA)), Granada Univ. (Spain). Dept. de Estadistica Mate-

mauca. R. Gutierrez Jaimez, and E. Moreno Bas. IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volume II, 1984. SIAMOS 78. p 751-773, 1 fig, 6

Descriptors: \*Geomorphology, \*Drainage pat-terns, \*Drainage, \*Drainage area, \*Model studies, \*Catchment areas, Underground structures, Darro River, Granada, Infiltration rate, Infiltration, Mathematical models, Mathematical equations, Drainage density, Density.

The drainage pattern is controlled by the structure and is it a decisive factor in the infiltration rate. and is it a decirity factor in the limitation rate. For this reason, the analysis of this pattern is of special interest in the underground works areas for the study of the preferential flow lines. The accuracy of a log normal model for describing the observed random variables 'length of the link' and 'areas of drainage' is proven. Starting with this areas or grainage: is proven. Starting with this bivariate model, a theoretical model for describing the random variable 'density of drainage' is developed. After adequate statistical analysis it was found that the model can be accepted to a high level of significance. (See also W87-09568) (Author's abstract) thor's abstract) W87-09872

FREE SURFACE FLOW IN POROUS MEDIA BY FINITE ELEMENT METHODS.

BY FINTLE ELEMENT METHODS, Minho Univ., Braga (Portugal). J. B. Martins, A. C. Matos, and A. Bianchi. IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volume II, 1984. SIAMOS 78. p 825-846, 13 fig, 31

Descriptors: \*Groundwater movement, \*Water table, \*Model studies, \*Porous media, \*Percolation, \*Finite element method, \*Data interpretation, Mathematical studies, Mathematical equations, Steady state flow, Flow, Boundary conditions, Nonhomogeneity, Anisotropy.

Steady-state flow through porous media is analyzed. Governing equations and boundary conditions are set up and discussed. Variational methods and the finite element approach are described and the solving system of equations for quadrilateral networks of triangular linear condensed elements is obtained. Non-homogeneity and anisotropy are discussed. Further discussion on the finite element techniques and on the convergence of the numerical process is provided. The convergence of the finite elements approach to the solution of the free surface flow problem means essentially that for properly posed problems when the maximum size of the mesh tends to zero the finite elements solu-

tion tends to the exact one, which is unique. It does not mean that for a given mesh with a fixed number of nodal points and a given form of discretization there is a polygonal free surface such that the potential exactly coincides with the elevation the rate of flow being simultaneous null at the vertices. (Wood-PTT) W87-09876

INFLUENCE OF POTASSIUM MINING IN CA-INFLUENCE OF POTASSIUM MINING IN CA-TALONIA ON THE QUALITY OF THE WATER OF THE LLOBREGAT RIVER (BARCELONA) (INFLUENCIA DE LA MINERIA POTASICA CATALANA EN LA CALIDAD DEL AGUA DEL RIO LLOBREGAT (BARCELONA)),

Comisaria de Aguas del Pirineo Oriental, Barcelo-

For primary bibliographic entry see Field 5B. W87-09886

WATER IN THE MINING OF SOFT COAL, A STUDY OF A PILOT AREA (EL AGUA EN LA MINERIA DE LA HULLA, ESTUDIO DE UNA ZONA PILOTO), Empresa Nacional Adaro de Investigaciones Min-

Empresa Nacional Adato de investigaciones eras S.A., Madrid (Spain). For primary bibliographic entry see Field 5B. W87-09887

WATER IN MINING.

State Irrigation Commission, Lucknow (India).

A. C. Chaturvedi.

IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterrancos), Volumes I and II, 1984. SIAMOS 78. p 1195-1205, 3 tab, 11 ref.

Descriptors: \*Groundwater management, \*India, \*Data interpretation, \*Data acquisition, \*Mine drainage, Streamflow, Reservoir, Model studies, Mathematical studies, Hydrologic studies, Bharatpurha Creek, Chabiyar Creek, Flow profiles.

The control of ground water pressure, is an impor-tant component activity for mining in South India. Since the commencement of mining operations a lot of hydrological and pumping data has been collected since 1940. With the availability of the data and the likelihood of more severe hydrological conditions being encountered in mining the coming decade, a computor oriented study of the problem of mine water control was initiated. Al-though reservoir systems are to be designed in the face of hydrologic uncertainty, an investigation into the effect of this uncertainty on the performance of a system design is a basic objective. Synthetic streamflow data were generated by evolving a flow model and alternate sequences were used in simulation of reservoir operations. The perfor-mance of the design was measured by the deficit index. Variations in the deficit index when alternate synthetic data sequences were used reflected the hydrologic uncertainty involved. An objective approach to the determination of the adequacy of synthetic data sequences was worked in terms of the desired accuracy of the estimate of deficit index. The extreme low flow volume for Bharatpurha Creek were 5 to 15 times greater than the corresponding values on the Chabiyar Creek. In each case the comparison of the least square feet time and the equal yield line shows for the sub basins affected by strip mining, higher unit dis-charge during low flow periods. (Author's abstract) W87-09898

COMPUTATION OF FLOOD FLOWS IN OPEN

Institut za Vodoprivredu Jaroslav Cerni, Belgrade (Yugoslavia).

N. Marjanovic, and S. Prohaska.

N. Marjanovic, and S. Pronaska. In: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol-umes I and II, 1984. SIAMOS 78. p 1265-1274, 2

Descriptors: \*Flood flow, \*Flood forecasting, \*Flooding, \*Floods, \*Rainfall-runoff relationships, \*Mathematical equations, \*Data interpretation,

Flood recurrence interval, Mining engineering, Open pit mines, Rainfall, Runoff, Surface runoff, Runoff coefficient.

A method for computing flood flows of different recurrence intervals under open pit working condi-tions is presented. The method applied is based on the well known relationship between maximum overland flow rate per unit drainage area and the rainfall depth for the relevant time of storm dura-tion and the runoff coefficient. Application of the method is illustrated for open pit working condi-tions. (Author's abstract) W87-09903

SEDIMENTARY PROCESSES, VERTICAL STRATIFICATION SEQUENCES, AND GEO-MORPHOLOGY OF THE ROARING RIVER ALLUVIAL FAN, ROCKY MOUNTAIN NATIONAL PARK, COLORADO, Colorado Univ. at Boulder. Dept. of Geological

For primary bibliographic entry see Field 2J. W87-09918

IN THE UNITED STATES - FLASH FLOODS

AND DROUGHT, National Environmental Satellite, Data, and Information Service, Washington, DC. D. Le Comte. Weatherwise WTHWA2, Vol. 40, No. 1, p 12-16,

February 1987.

Descriptors: \*Flooding, \*Rainfall, \*Precipitation, \*Weather data collections, \*Data collections, Flood damage, Flood frequency, Floods, Flash floods, United States, Drought, Snow, Precipitation excess, Crop yield, Excess rainfall.

Record high and low temperatures, unusually large rainfall amounts, and late snowstorms were reported for various parts of the USA in 1986. The Southeast, meanwhile, suffered from the worst drought experienced in 100 years. There was record flooding in October which damaged farmland along the Missouri and Arkansas Rivers. Flooding from rivers, lakes, or oceans caused billions of dollars of damage in Alaska, Montana, Michigan, California, and other states. Because tropical storm and tornado damage was light and Michigan, Cantorna, and other states. Decause tropical storm and tornado damage was light and the weather favorable in the midwestern farm belt in 1986, the yields of corn, wheat and soybeans from that area was good though not record-setting. (Wood-PTT) W87-09927

SATELLITE APPLICATIONS IN RIVER AND FLOOD FORECASTING,

National Weather Service, Silver Spring, MD. Office of Hydrology. For primary bibliographic entry see Field 7B. W87-09955

USE OF RADAR IMAGERY FOR SURFACE WATER INVESTIGATIONS, Jet Propulsion Lab., Pasadena, CA. For primary bibliographic entry see Field 7B. W87-09989

EXAMINATION OF FLUVIAL MORPHOLOG-ICAL CHARACTERISTICS OF WESTERN AMAZON STREAMS FROM APOLLO-SOYUZ PHOTOGRAPHS,

Texas Univ. at Austin. Dept. of Geological Sci-

ences.
R. K. Holz, and V. R. Baker.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 252-259, 7 fig, 3 tab, 9 ref.

Descriptors: \*Geomorphology, \*Remote sensing, \*Aerial photography, \*Hydrology, \*Geohydrology, \*Aircraft, \*Satellite technology, \*Solimoes River, \*Japura River, Jurua River, River basins, Photography, Morphology.

Three major river types, based on sinuosity (P) and other properties, were distinguished from color

#### Groundwater-Group 2F

photographs generated by the Apollo-Soyuz Test Project (ATP) in July 1975. Three rivers were chosen representative of these types and the remarkable variations in fluvial regime and morphology that exist in the Amazon Basin. These rivers include the Solimos P = 1.2 to P = 1.4, the Japura, P = 1.1, and Jurua, P = 1.8 to P = 3.0. Empirical formula were tested in estimating the hydrologic properties of these South American rivers. The study demonstrates the lack of precise understanding of regime behavior in tropical streams and the difficulty of transferring the results of research on humid mid-latitude and semi-arid mid-latitude streams to those of the humid tropical areas. The results show that the low sinuosity Amazon Basin streams transport much finer sediareas. The results show that the low sinuosity Amazon Basin streams transport much finer sediment than do streams of equivalent sinuosity. Many of the fluvial complexities of the western Amazon Basin appear to result from the relative abilities of different rivers to rework coarse, relict alluvium that was deposited during the relatively arid full-glacial phases of the Pleistocene. (See also W87-09953) (Author's abstract) W87-09990

OPTICAL AND DIGITAL ANALYSES OF LANDSAT DATA DEPICTING HYDROGEOLO-GICAL FEATURES OF THE DARYACHEH-YE-NAMAK AREA, IRAN,

Nova Scotia Land Survey Inst., Lawrencet For primary bibliographic entry see Field 7B. W87-09993

IMPROVING STREAM FLOW ESTIMATES THROUGH THE USE OF LANDSAT,
Geological Survey, Madison, WI. Water Re-

G. J. Allord, and F. L. Scarpace.

G. J. Alfold, and P. E. Scarpace.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 284-291, 4 fig. 2 tab, 7 ref.

Descriptors: \*Streamflow, \*LANDSAT, \*Satellite technology, \*Forecasting, \*Remote sensing, \*Hydrology, \*Wisconsin, Statistical analysis, Regression analysis, Topography, Discharge, Land use.

Estimates of low flow and flood frequency in several southwestern Wisconsin basins have been significantly improved by determining land cover from LANDSAT imagery. With the use of new estimates of land cover in multiple regression techniques, the standard error of estimate (SE) for the least annual 7-day low flow for 2- and 10-year recurrence intervals of ungaged sites were lowered by 9% each. The SE of flood frequency in the Drilless Area of Wisconsin for 10-, 50-, and 100-year recurrence intervals were lowered by 14%. Four of nine basin characteristics determined from satellite imagery were significant variables in the multiple regression techniques, whereas only 1 of the 12 characteristics determined from topographic maps was significant. The percentages of land cover categories in each basin were determined by merging basin boundaries, digitized from quadrangles, with a classified Landsat scene. Low flow relations in the lower Wisconsin River basin were improved 17 to 20% when Landsat land use data were used in developing the relations. Land use did not prove to be a timificant vagishle in the improved 17 to 20% when Landsat land use data were used in developing the relations. Land use did not prove to be a significant variable in the Pecatonica-Sugar River basin for low flow estimates. Estimates for the flood freguency relations with recurrence intervals of 10, 50, and 100 years were improved 45 to 50%. Landsat data can be used to significantly improve relations for predicting streamflow characteristics. These improvements will result in a more accurate determination of water resources and will aid in management decisions. (See also W87-09953) (Lantz-PTT) W87-09994

#### FLOOD APPLICATIONS OF SATELLITE IM-

Atmospheric Environment Service, Downsview (Ontario).

For primary bibliographic entry see Field 7B. W87-09995

ASSESSING THE RED RIVER OF THE NORTH 1978 FLOODING FROM NOAA SAT-

National Environmental Satellite, Data, and Information Service, Washington, DC.
For primary bibliographic entry see Field 7B.
W87-09997

PRELIMINARY ANALYSIS OF SAR MAPPING OF THE MANITOBA FLOOD, MAY 1979, INTERA Environmental Consultants Ltd., INTERA Environmental Consultants
Ottawa (Ontario).
For primary bibliographic entry see Field 7C.
W87-09998

DELINEATION OF DRAINAGE AND PHYSIO-GRAPHIC FEATURES IN NORTH AND SOUTH DAKOTA USING NOAA-5 INFRARED

National Environmental Satellite, Data, and Information Service, Washington, DC.
S. R. Schneider, D. F. McGinnis, and J. A.

Pritchard.
In: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 324-330, 8 fig. 12 ref.

Descriptors: \*Drainage patterns, \*Satellite technology, \*Mapping, \*Infrared imagery, \*North Dakota, \*South Dakota, \*Missouri Rivers, \*Hydrology, \*Remote sensing, Geohydrology, Drainage, Geomorphology, Flow pattern, Rivers.

age, Geomorphology, Flow pattern, Rivers.

Enhanced nighttime 1-km thermal infrared imagery and digital data from the NOAA-5 polar orbiting satellite were used to map drainage patterns and landforms in North and South Dakota. Fearures delineated include the Missouri Escarpment from Saskatchewan to the Nebraska border, the Manitoba Escarpment, Coteau des Prairies, recessional moraines on the Coreau du Missouri, and partial drainage boundaries for the following rivers: James, Big Sioux, Minnesota, Red of the North, Souris, and the main stem of the Missouri plus its western tributaries in the Dakotas. In several instances drainage from gentle slopes in the Midwest was discerned and correlated with local relief. Analysis of the satellite digital thermal data for western tributaries of the Missouri River, using topographic maps for location determination, revealed north-facing slopes to be warmer than south-facing slopes to an average of 1.5 C. The authors attribute this phenomenon to differences in soil moisture between north- and south-facing slopes. (See also W87-09953) (Author's abstract) W87-09999

ANDEUT EMERGENCE IN A STRETCH THE PO RIVER (ITALY), Milan Univ. (Italy). Sezione di Ecologia. For primary bibliographic entry see Field 2H. W87-10096 INSECT EMERGENCE IN A STRETCH OF

EFFECTS OF SEASONAL AND HYDROLOGICAL INFLUENCES ON THE MACROINVERTEBRATES OF THE RHONE RIVER, FRANCE 1. METHODOLOGICAL ASPECTS, Lyon-1 Univ. (France).
For primary bibliographic entry see Field 2H.
W87-10099

#### 2F. Groundwater

HANGINGWALL DEWATERING AT MUFU-LIRA DIVISION OF ROAN CONSOLIDATED MINES LIMITED, ZAMBIA, Roan Consolidated Mines Ltd., Mufulira (Zambia). Mufulira Div.

In: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol-umes I, 1984. SIAMOS 78. p 559-571, 4 fig, 2 ref.

Descriptors: \*Dewatering, \*Mining engineering, \*Mine drainage, \*Aquifers, \*Drainage engineering, \*Pumping, Geohydrology, Monitoring, Pumping

plants, Groundwater movement, Grouting, Weirs.

Hanging wall dewatering is an integral and essential feature of the mining policy at Mufulira Division, Zambia due to the utilization of caving methods of mining. Five major aquifer zones occur at distinct stratigraphic herizons, and all have to be drained or checked for water potential before mining can be carried out within the area. The drainage program involves the removal of about five tons of groundwater for each ton of ore that is mined. Major aquifers are drained by driving crosscuts into them, thereby releasing the water. The crosscuts are advanced behind watertight doors and bulkheads fitted with drain pipes, valves, air, water and power cables. Pressures and flows of water from major sources and quantities reporting air, water and power cables. Pressures and flows of water from major sources and quantities reporting to pump stations are constantly monitored. A system of settling sumps removes suspended particles that would damage the pumps. Sludge disposal is by a Wilson Snyder highlift sludge pump. (See also W87-09568) (Geiger-PTT) W87-09602

OPEN PIT MINE SLOPES DRAINAGE THROUGH HORIZONTAL BOREHOLES, Geotecnica S.A., Sao Paulo (Brazil). For primary bibliographic entry see Field 4B. W37-09603

PRECAUTION MEASURES AGAINST SUDDEN INRUSHES OF WATER AND MUD IN COLLIERIES OF SFR YUGOSLAVIA, Vindiana Hair. (Yugoslavia). Faculty of Natural Ljubljana Univ. (Yugoslavia). Faculty of Ni Sciences and Technology. For primary bibliographic entry see Field 4B. W87-09604

RECENT ASPECTS OF STUDY METHODS OF DRAINAGE OF OPEN PITS EXCAVATIONS (ASPECTS RECENTS DES METHODES D'ETUDE DU DRAINAGE DES MIN'ES A CIEL OUVERT),

Bureau de Recherches Geologiques et Minieres, Orleans (France).
For primary bibliographic entry see Field 6A.
W87-09605

DEWATERING AND SETTLEMENT IN THE BANK COMPARTMENT OF THE FAR WEST RAND, SOUTH AFRICA, Imperial Coll. of Science and Technology, London (England). Dept. of Geology. For primary bibliographic entry see Field 4C. W87-09606

METHODOLOGY AND APPLICATION OF ANALYSING ROCK-WATER INTERACTION ENDANGERING MINES, Mining Development Central Inst., Budapest (Hungary). For primary bibliographic entry see Field 8E. W87-09607

CAVING OF A COAL SEAM UNDER KAMP-TEE AQUIFERS OF INDIA, Central Mining Research Station, Dhanbad (India). T. N. Singh, and B. Singh. IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol-umes I, 1984. SIAMOS 78. p 657-673, 8 fig. 2 tab,

Descriptors: \*Mining engineering, \*Model studies, \*Coal mining, \*Pumping, \*Mine drainage, Geohydrology, Aquifers, Drainage engineering, Drainage programs, Groundwater recharge, Groundwater

Caving under the highly aquiferous conditions of the Chanda-Wardha Valley of Maharashtra re-quires anticipation of pumping load at different stages. An equivalent mine model was developed to visualize the sequence of caving of different formations. Results showed that the extraction of early a 2.7 m thick coal section under a strong

#### Group 2F-Groundwater

band of shaly coal of 11 m thickness caused negligible deformation up to 40 m advance. The first fall affecting the full roof coal section occurred with 48 m advance. The coal roof served as a strong immediate roof and delayed the first major fall. The presence of different aquifers changed the caving characteristics and fracture patterns. The first fall caused a sudden release of water from the caved mass, radial inflow along the periphery of the caved dome, and transverse leakage from the upper aquifers. The effects of recharge by precipitation, seepage through the surface water bodies and leakage/inflow from adjacent aquifers should also be considered in the drainage solutions. On the basis of the model analysis and extrapolated caving characteristics, the inflow appears to fluctuate with advance of the face within 2,000-8,000 gpm. This calls for well designed pumping installations with a capacity 4-5 times that of the normal radial flow. A large sump, in addition to adequate escape routes will be required. (See also W87-09568) (Geiger-PTT)

DESIGN ASPECTS OF BARRIER PILLARS AGAINST WATER-LOGGED WORKINGS IN COAL MINING OPERATIONS,

Nottingham Univ. (England). Dept. of Mining Engineering. For primary bibliographic entry see Field 8A.

SCALE PROBLEMS IN HYDROLOGY: RUNOFF GENERATION AND BASIN RE-SPONSE.

For primary bibliographic entry see Field 2A. W87-09610

RUNOFF SIMULATION MODEL BASED ON HILLSLOPE TOPOGRAPHY, Leeds Univ. (England). School of Geography. For primary bibliographic entry see Field 2A.

SPATIAL HETEROGENEITY AND SCALE IN THE INFILTRATION RESPONSE OF CATCH-MENTS.

MENTS, Princeton Univ., NJ. Dept. of Civil Engineering. For primary bibliographic entry see Field 2A. W87-09615

INCORPORATION OF CHANNEL LOSSES IN THE GEOMORPHOLOGIC IUH, Massachusetts Inst. of Tech., Cambridge. Dept. of

Civil Engineering.
For primary bibliographic entry see Field 2A.
W87-09620

GROUNDWATER PROTECTION. Conservation Foundation, Washington, DC. For primary bibliographic entry see Field 4B. W87-09621

GROUNDWATER MANAGEMENT: THE USE OF NUMERICAL MODELS, Butler Univ., Indianapolis, IN. Holcomb Research

For primary bibliographic entry see Field 4B. W87-09623

SALT WATER INTRUSION: STATUS AND PO-TENTIAL IN THE CONTIGUOUS UNITED STATES,

STATES, Oklahoma Univ., Norman. Environmental and Ground Water Inst. For primary bibliographic entry see Field 5B. W87-09625

ARTIFICIAL RECHARGE OF GROUND WATER: STATUS AND POTENTIAL IN THE CONTIGUOUS UNITED STATES, Oklahoma Univ., Norman. Environmental and Ground Water Inst.
For primary bibliographic entry see Field 4B.

W87-09626

RADON-222 CONCENTRATION AND AQUI-FER LITHOLOGY IN NORTH CAROLINA, North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering. For primary bibliographic entry see Field 5B. W87-09666

POTENTIAL FOR SOLUTE RETARDATION ON MONITORING WELL SAND PACKS AND ITS EFFECT ON PURGING REQUIREMENTS FOR GROUND WATER SAMPLING, Oregon Graduate Center, Beaverton. Dept. of Environmental Science and Engineering. For primary bibliographic entry see Field 7B. W87-09667

SOME BIASES IN SAMPLING MULTILEVEL PIEZOMETERS FOR VOLATILE ORGANICS, Waterloo Univ. (Ontario). Dept. of Earth Sciences. For primary bibliographic entry see Field 7B. W87-09668

INTERCEPTOR TRENCHES FOR POSITIVE GROUND WATER CONTROL, Union Carbide Corp., Port Lavaca, TX. Polyofins

Div.
For primary bibliographic entry see Field 5B.
W87-09669

FAULT CONTROLLED HYDROGEOLOGY AT A WASTE PILE, Kaman Tempo, Santa Barbara, CA. For primary bibliographic entry see Field 5B. W87-09670

COMPARISON OF OFFICE-DERIVED VS. FIELD-DERIVED WATER TABLE MAPS FOR A SANDY UNCONFINED AQUIFER, Wisconsin Geological and Natural History Survey, Madison.

Macuson.
M. C. Blanchard, and K. R. Bradbury.
Ground Water Monitoring Review GWMRDU,
Vol, 7, No. 2, p 74-78, Spring 1987. 3 fig, 6 ref.

Descriptors: \*Aquifers, \*Water table maps, \*Comparison studies, \*Mapping, Topography, Field tests, Water table, Groundwater, Wells, Piezometers

This study compares the accuracy of two types of water table maps both of which were constructed with the object of optimizing future mapping efforts in similar environments. The first type of map is based solely on office information, with no field verification. The second type of map is based on careful field mapping using numerous measurement points. The office-derived maps were based on topography, surface water features, existing reports, maps and data in the files of the Wisconsin Geological and Natural History Survey; the data were not field-verified. The field-derived maps used a dense network of 236 piezometers at 176 sites in an area of approximately 170 square miles. The field project was much more expensive and labor-intensive than was the construction of office-derived maps for the same area. The two methods produce water table maps which agree to an appreciable extend, the greatest agreement being in areas having groundwater-fed streams. Differences in water table elevations indicated by the two methods range from negligible to approximately 5 feet. Thus, depending upon the availability of existing information, relatively accurate water table elevations can be delineated in similar sandy unconfined aquifers without time-consuming and expensive field work that drilling piezometer installation entails. Preliminary construction of office-derived water table maps enables researchers to use their resources efficiently. In some situations, expensive installation of wells and piezometers for a regional monitoring network may add little accuracy to the regional map. For localized problems, collection of additional field data will always be necessary, but can be guided by the office-derived maps. The authors caution that this technique may only be

applicable to sandy, unconfined aquifers in humid climates. (Author's abstract) W87-09672

SAMPLING THE CHEMISTRY OF SHALLOW AQUIFER SYSTEMS - A CASE STUDY, Agricultural Research Service, University Park, PA. Northeast Watershed Research Center. H. B. Pionke, and J. B. Urban. Ground Water Monitoring Review GWMRDU, Vol. 7, No. 2, p 79-88, Spring 1987. 5 fig. 3 tab. 19

Descriptors: \*Water analysis, \*Aquifers, \*Pennsylvania, \*Monitoring, Case studies, Wells, Pumping, Purging, Groundwater, Shale, Nitrates, Dissolved oxygen.

Pumped waters from 14 Pennsylvania wells, located in shallow sandstone, siltstone and shale aquifers, were continuously monitored for dissolved oxygen (D.O.), nitrate (NO3), pH, electrical conductivity (EC) and water temperature in a discharge manifold at the well head. The amount of pumping or purging required to stabilize these parameter readings varied by well site and parameter being analyzed. However, the purging required was generally greatest for D.O. and least for water temperature where. D.O. > NO3 - pH > EC > water temperature. Wells located near the silt-stone-shale interface generally required far more purging than did wells located elsewhere. Although parameter stability was often achieved within purging one bore volume, the complexity, diversity, and variability in the data and these well-ground water systems, suggest that no single purging required before sampling these shallow aquifers should be determined by incorporating on-site monitoring of target or related parameters into the purging process. From a sampling perspective, the relationship between NO3 and D.O. concentrations during purging were analyzed relative to aquifer type. For most wells located in sandstone or siltstone, NO3 concentrations remained relative-ly constant during purging irrespective of changes in D.O. For most wells located in shale, these two were positively and similarly correlated, suggesting that a general relationship exists. (Author's abstract)

MODELING OF GROUND-WATER FLOW IN THE CULEBRA DOLOMITE AT THE WASTE ISOLATION PILOT PLANT (WIPP) SITE: INTERIM REPORT,

TERIM REPORT, INTERA Technologies, Inc., Austin, TX. A. Haug, V. A. Kelley, A. M. LaVenue, and J. F. Pickens.

Available from the National Technical Information Service, Springfield, Virginia 22161. Contractor Report SAND86-7167, March 1987. 236 p, 58 fig, 22 tab, 118 ref, 6 append.

Descriptors: \*Underground waste disposal, \*Injection wells, \*Groundwater movement, \*Culebra dolomite, \*Model studies, \*Disposal sites, \*Waste disposal, Geohydrology, Transmissivity, Fluid density, Simulation analysis, Hydraulic profiles, Well tests, Flow profiles, Pressure head.

Well tests, Flow profiles, Pressure head.

The modeling studies of groundwater flow in the Culebra Dolomite Member of the Rustler Formation reported here were performed as part of the regional hydrologic characterization studies for the Waste Isolation Pilot Plant (WIPP) site in southeastern New Mexico. The objectives of this report are to: (1) document the hydrogeologic data base for the Culebra dolomite at the WIPP site (including Culebra elevations, transmissivities, fluid densities, freshwater heads, and hydrologic stresses during the period 1981-1986); (2) develop a conceptualization and modeling strategy for describing groundwater flow in the Culebra; (3) present the calibration approach and results for simulating groundwater flow in the Culebra under undisturbed hydraulic conditions and during the transient period (1981 to 1986) resulting from shaft activities and well tests (in particular, the H-3 multipad pumping test); (4) present the results of sensitivity analyses to assess the impact of vertical

#### Groundwater-Group 2F

fluxes to the Culebra on the freshwater head and fluid density distributions; and (5) present the results of calculations and analyses to assess the impact of double-porosity flow on the transient behavior of the simulated hydrogeology in the Culebra dolomite. The spatial scale for the numerical model utilized in this study was chosen to allow a quantitative evaluation of the H-3 multipad pumping tests and to allow a preliminary assessment of groundwater flow in the Culebra at the WIPP site. As such, it encompasses the WIPP site and its immediate surroundings. The model is relatively detailed since it includes the area containing the majority of the available monitoring and test wells in this region. (Lantz-PTT)

GROUNDWATER RESOURCE ASSESSMENT AND MANAGEMENT RECOMMENDATIONS FOR OUTAGAMIE COUNTY, WISCONSIN, Fox Valley Water Quality Planning Agency, Menasha, WI. For primary bibliographic entry see Field 4B. W87-09690

DESIGN OF A STATEWIDE GROUND WATER MONITORING NETWORK, Tennessee Technological Univ., Cookeville. Center for the Management, Utilization and Pro-

tection of Water Resources.
For primary bibliographic entry see Field 7A.
W87-09747

MICROBIOLOGICAL CLEANUP OF PEN-TACHLOROPHENOL-CONTAMINATED GROUNDWATER, BioTrol, Chaska, MN. For primary bibliographic entry see Field 5F. W87-09774

HYDROGEOLOGIC AND GEOCHEMICAL EVOLUTION OF CONTAMINATED GROUND-WATER NEAR ABANDONED MINES, Wisconsi Center. Univ.-Madison.

For primary bibliographic entry see Field 5B. W87-09782

POTENTIOMETRIC SURFACE OF THE FLOR-IDAN AQUIFER SYSTEM IN CENTRAL SUMTER COUNTY, FLORIDA, MAY 1985, Geological Survey, Orlando, FL. Water Resources

Available from USGS, Box 25425, Denver, CO 80225. USGS Open File Report 85-551, 1985. 1 sheet (map).

Descriptors: \*Potentiometric level, \*Groundwater, \*Florida, \*Maps, Hydrologic aspects, Aquifers, Geohydrology, Sumter County.

This map presents the potentiometric surface of the This map presents the potentiometric surface of the Floridan aquifer system in central Sumter County, Florida, for May 1985. The Floridan aquifer system is the principal source of portable water in the area. The focus of the map is the potentiometric surface in the Jumper Creek Canal area. Water-level measurements were made on approximately 60 wells. The potentiometric surface ranged in altitude from more than 90 feet in the southeastern part of the county to less than 35 feet northwest of Lake Panasoffkee in the west-central area. (USGS) area. (USGS) W87-09808

SELECTED HYDROLOGIC DATA FROM THE NORTHERN PART OF THE HUECO BOLSON, NEW MEXICO AND TEXAS,

Geological Survey, Albuquerque, NM. Water Re-

sources Div.

B. R. Orr, and R. R. White.

Available from USGS, OFSS, Box 25425, Denver,

CO 80225. USGS Open File Report 85-696, 1985.

88 p, 23 fig, 6 tab, 66 ref.

Descriptors: \*Groundwater, \*Water use, \*Water-level fluctuations, \*Groundwater data, \*New

Mexico, \*Texas, Lithologic logs, Irrigation and municipal well logs, Tularosa Basin, Dona Ana County, El Paso County.

Hydrologic data were collected in early 1985 from the northern part of the Hueco Bolson in Dona Ana County, New Mexico, and El Paso County, Texas, and in adjacent areas in the Tularosa Basin in New Mexico. Water-level measurements made in 50 wells are presented in this report. Information is also presented on groundwater withdrawals from the Hueco Bolson by El Paso and Ciudad Juarez municipal wells, by industrial and military wells, and by wells in the Chaparral, New Mexico, area that have been used for both irrigation and municipal purposes. Lithologic logs and geophysical logs are included for four test wells that were drilled as part of this project during August and September 1985. (USGS)

SOURCES OF CLIMATOLOGIC, HYDROLOGIC, AND HYDRAULIC INFORMATION IN THE ILLINOIS RIVER BASIN,
Geological Survey, Urbana, IL. Water Resources

For primary bibliographic entry see Field 10C. W87-09813

HYDROLOGIC DATA FOR THE SOUTH-CEN-TRAL AREA, NEBRASKA, Geological Survey, Lincoln, NE. Water Resources

For primary bibliographic entry see Field 2E. W87-09818

SUMMARY OF WATER RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN FISCAL YEAR 1986,

Geological Survey, Lakewood, CO. Water Resources Div.

J. M. Stewart. Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 86-70, 1986. 70

Descriptors: \*Hydrology, \*Water quality, \*Surface water, \*Groundwater, \*Colorado, Water records.

The annual summary of water records activities in Colorado is presented for fiscal year 1986. The report includes an introduction of these activities report includes an introduction of these activities and names of the management personnel to whom information requests may be addressed; a summary of the U.S. Geological Survey mission and of the Water Resources Division mission; and a discussion of the water conditions in Colorado in fiscal year 1986, including data collection on surface water and groundwater. All current Colorado hydrologic investigations are listed—their problems, objectives, approaches, progress, and plans for fiscal year 1986. A list of current cooperators for fiscal year 1986 and a list of reports published or observed during fiscal year 1986 and a list of reports published or observed during fiscal year 1986 and a list of reports published or observed during fiscal year 1986 and a list of reports published or observed during fiscal year 1986 and a list of reports published or observed during fiscal year 1986 and a list of reports published or observed during fiscal year 1986 and a list of reports published or observed during fiscal year 1986 and a list of reports published or observed during fiscal year 1986 and a list of reports published or observed during fiscal year 1986 and a list of reports published or observed during fiscal year 1986 and a list of reports published or observed during fiscal year 1986 and a list of reports published or observed during fiscal year 1986 and a list of reports published or observed during fiscal year 1986 and a list of reports published or observed during fiscal year 1986 and a list of reports published or observed during fiscal year 1986 and a list of reports published or observed during fiscal year 1986 and a list of reports published or observed during fiscal year 1986 and a list of the published or observed during fiscal year 1986 and a list of published or observed during fiscal year 1986 and a list of reports published or observed during fiscal year 1986 and a list of published or observed during fiscal year 1986 and a list of publing fiscal year 1986 and a list of published or observed during f inscai year 1986 and a list of reports published or released during fiscal year 1984, 1985, and 1986 also are given. (USGS) W87-09821

GROUND-WATER DATA FOR THE HANNA AND CARBON BASINS, SOUTHCENTRAL WYOMING, THROUGH 1980, Geological Survey, Cheyenne, WY. Water Re-

sources Div.
P. B. Daddow.
Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 85-628, 1986. 91 p, 4 fig, 3 tab, 12 ref.

Descriptors: \*Coal mining, \*Groundwater, \*Lithologic logs, \*Water levels, \*Well data, \*Water resources, \*Wyoming, Carbon County, Hanna and

Groundwater resources in the Hanna and Carbon Basins of Wyoming were assessed in a study from 1974 through 1980 because of the development of coal mining in the area. Data collected from 105 wells during that study, including well-completion records, lithologic logs, and water levels, are pre-

sented. The data are from stock wells, coal-test holes completed as observation wells by the U.S. Geological Survey. The data are mostly from mined coal-bearing formations: the Tertiary Hanna Formation and the Tertiary and Cretaceous Ferris Formation. Well-completion data and lithologic logs were collected on-site during drilling of the wells or from U.S. Geological Survey files, company records, Wyoming State Engineer well-permit files, and published reports. (USGS)

COMPILATION OF REFERENCES ON GEOLOGY AND HYDROLOGY OF THE SNAKE RIVER DRAINAGE BASIN ABOVE WEISER,

IDAHO, Geological Survey, Boise, ID. Water Resources

M. D. Bassick. Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 86-245, 1986. 133 p, 1107 ref.

Descriptors: \*Geology, \*Hydrology, Geophysics, Geochemistry, Water resources, Groundwater, Bibliographies

More than 1,100 references concerning geology and hydrology of the Snake River drainage basin above Weiser, Idaho, are compiled as part of the U.S. Geological Survey's RASA (Regional Aquifer-System Analysis) study of the Snake River Plain. The list of references is intended as a primary source of information for investigators concerned with previous studies in the basin. Reference numbers correlate with a key-word index to help the user select and locate desired references. (USGS) W87-09824

ACTIVITIES OF THE WATER RESOURCES DIVISION, CALIFORNIA DISTRICT, IN THE 1985 FISCAL YEAR, Geological Survey, Sacramento, CA. Water Re-sources Div.

For primary bibliographic entry see Field 2E. W87-09825

ANNUAL WATER-RESOURCES REVIEW, WHITE SANDS MISSILE RANGE, NEW MEXICO, 1985, Geological Survey, Albuquerque, NM. Water Resources Div.

R. R. Cruz. Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 86-401, 1986. 21 p, 8 fig, 5 tab, 3 ref.

Descriptors: "Hydrologic data, "Groundwater data, "Water quality, "New Mexico, Potentiometric levels, Slope-area measurement, Peak flow, White Sands Missile Range.

Hydrologic data were collected at White Sands Missile Range, NM, in 1985. The total groundwater withdrawal in 1985 was 676,433,800 gallons. The 11 supply wells in the Post Headquarters well field produced 642,056,000 gallons, or about 95 percent of the total. The six Range area supply wells produced 34,377,800 gallons. The total groundwater withdrawal was 8,841,200 gallons less in 1985 than 1984. Water samples from six Post Headquarters supply wells were collected for major chemical analysis. Water samples from 19 other wells were collected for pH and specific-conductance analysis. Depth-to-water measurements in the Post Headquarters supply wells showed seasonal fluctuations as well as continued long-term declines. (USGS) W87-09826

JANUARY 1986 WATER LEVELS, AND DATA RELATED TO WATER-LEVEL CHANGES, WESTERN AND SOUTH-CENTRAL KANSAS, Geological Survey, Lawrence, KS. Water Re-sources Div.

B. J. Dague. Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 86-317, 1986.

#### Group 2F-Groundwater

165 p. 2 fig. 1 tab. 17 ref.

Descriptors: \*Groundwater, \*Water level changes, \*Hydrologic data, \*Kansas, Data collections.

Hydrologic data related to water level measurements were made in observation wells in western and south-central Kansas. The measurements were made in midwinter when pumping was minimal and water levels had recovered, for the most part, from the effects of pumping during the previous irrigation season. Annual hydrologic data are provided for relating water-level changes from a base-reference year (predevelopment year), a year of abnormally large amounts of rainfall and minimum pumpage (1966 or 1974), and each of 7 consecutive years of measurement (1980-86). The base-reference year is designated as 1940 for the southwestern area, 1944 for the south-central area, and 1950 for the northwestern, west-central, and Equus beds areas. Data also are provided for relating the average annual water level changes, satu-Hydrologic data related to water level measureing the average annual water level changes, saturated thicknesses of the deposits, and percentage changes in saturated thickness. (USGS) W87-09827

GROUND-WATER LEVELS IN ARKANSAS.

SPRING 1986, Geological Survey, Little Rock, AR. Water Re-

Sources Div.

J. Edds, and L. M. Remsing.

Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 86-406, 1986. 62 p. 3 fig. 16 tab, 23 ref.

Descriptors: \*Groundwater levels, \*Aquifers, \*Ar-kansas, Well hydrographs, Alluvial aquifer, Sparta

Groundwater level measurements were made in 690 observation wells in Arkansas in the spring of 690 observation wells in Arkansas in the spring of 1986. In addition, well hydrographs are given for aquifers in the Quaternary deposits and the Sparta Sand, the most important aquifers with respect to groundwater availability and use in Arkansas. Water levels in the Quaternary deposits in the 25 heavily irrigated counties of eastern Arkansas overall rose 1.3 feet between 1981 and 1986. The average rise in water levels from 1981 to 1986 reflects, at least in part, the recovery of water levels in the Quaternary deposits, following the drought of 1980 and is in contrast to the long-term declines that persist in many parts of eastern Arkansas of the property of the parts of t drought of 1990 and is in contrast to the long-term declines that persist in many parts of eastern Arkansas. In Arkansas, Columbia, Jefferson, Ouachita, and Union Counties where withdrawals from the Sparta aquifer are greatest water-level changes ranged from a decline of 1.5 feet to a rise of 7.9 feet between 1981 and 1986. (USGS) W87-09828

APPLICATION OF BOREHOLE ACOUSTIC METHODS IN THE CHARACTERIZATION OF DEEPLY BURIED BASALT FLOWS, Geological Survey, Denver, CO. Water Resources

For primary bibliographic entry see Field 7B. W87-09829

POTENTIOMETRIC SURFACE OF THE UPPER FLORIDAN AQUIFER, WEST-CEN-TRAL FLORIDA, MAY 1986,

Geological Survey, Tampa, FL. Water Resources

G. L. Barr, and B. R. Lewelling. Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 86-409, 1986. 1 sheet (map), 2 fig, 2 ref.

Descriptors: \*Potentiometric level, \*Maps, \*Florida, Potentiometric flow, Hydrology, Hydrogeo-

A May 1986 potentiometric surface map of the Upper Floridan aquifer in west-central Florida depicts the annual low water-level period. Water levels in most wells measured in May 1986 were lower than in September 1985. May 1986 levels averaged about 2 feet lower than September 1985 levels in areas north of latitude 28 degrees 07 feet and about 9 feet lower in southern areas. Water

levels in individual wells in May 1986 averaged about 2 feet higher than May 1985 levels. (USGS) W87-09830

GROUND-WATER LEVELS IN THE ALLUVI-AL AQUIFER IN EASTERN ARKANSAS, 1984, Geological Survey, Little Rock, AR. Water Resources Div. M. Plafcan.

Available from USGS, OFSS, Box 25425, Lakewood, CO 80225. USGS Open File Report 85-569, 1985. 26 p, 2 fig, 1 tab, 2 ref.

Descriptors: \*Groundwater level, \*Alluvial aquifers, \*Arkansas, Aquifer characteristics, Mississippi River Valley alluvial aquifer, Lonoke County, Mississippi County.

This report, prepared by the U.S. Geological Survey in cooperation with the Arkansas Soil and Water Conservation Commission, the U.S. Soil Conservation Service and local Conservation Districts, contains groundwater level measurements in tricts, contains groundwater level measurements in 452 wells tapping the Mississippi River Valley alluvial aquifer of eastern Arkansas. The measurements were made by the U.S. Soil Conservation Service during 1984. The purpose of this report is to provide these data to other State and Federal agencies as well as to private landowners. On the average, a decline of 2.5 feet in water levels was observed throughout the study area after the pumping season. (USGS) W87-09833

SUMMARY OF AVAILABLE GROUND-WATER DATA FOR THE ISLAND OF OAHU,

WATER DATA LANGE HAWAII,
Geological Survey, Honolulu, HI. Water Resources Div.
S. E. Miyamoto, C. E. Miyaji, and L. L. K.

Fukuda. Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 86-233, 1986. 216 p, 3 fig. 10 tab, 2 ref.

Descriptors: \*Groundwater, \*Data collections, \*Hydrologic data, \*Hawaii.

This report presents, in tabular form, descriptive information and information on the availability of chloride concentration, water level, pumpage, log, pump test and flow data for all wells, shafts and tunnels on Oahu, Hawaii. Descriptive data for each groundwater source include: identification number, groundwater source include: identification number, map number, depth, diameter, year completed, owner, usage and status. The report is based on data currently available in the files of the U.S. Geological Survey and is a compilation of observations made by Survey personnel, and information gathered by other agencies and the private sector. (USGS) W87-09836

RECORDS OF WELLS AND CHEMICAL ANALYSES OF GROUND WATER IN BROWN COUNTY, SOUTH DAKOTA,
Geological Survey, Huron, SD. Water Resources

Geological Garage, Div.
K. M. Neitzert, and N. C. Koch.
Available from USGS, OFSS, Box 25425, Denver,
CO 80225, USGS Open File Report 86-147, 1986.

Descriptors: \*Well data, \*Hydrologic data, \*Data collections, \*South Dakota, Brown County.

Well and chemical groundwater data contained in two tables were collected during a 5-year study started in 1967 to determine the geology and water resources of Brown County, South Dakota. Physical, hydrologic, and geologic data for 3,127 wells and test holes have been entered into computer storage in the Ground-Water Site Inventory File of the U.S. Geological Survey's National Water Data Storage and Retrieval System (WATSTORE). The well table in the report is a computer printout from WATSTORE. Water quality data from 750 chemical analyses has been stored in the Water-Quality File of WATSTORE and is computer printed in the chemical analyses table by aquifer. (USGS) quifer. (USGS)

W87-09837

POTENTIOMETRIC SURFACE OF THE UPPER FLORIDAN AQUIFER IN THE ST. JOHNS RIVER WATER MANAGEMENT DISTRICT AND VICINITY, FLORIDA SEPTEM-**RER 1985** 

Geological Survey, Orlando, FL. Water Resources

Div. G. R. Schiner, and E. C. Hayes. Available from USGS, OF'SS, Box 25425, Lakewood, CO 80225. USGS Open File Report 85-644, 1985. 1 sheet (map).

Descriptors: \*Potentiometric surface, \*Floridan aquifer, \*Florida, \*Maps, Groundwater, Hydrolog-ic aspects, Aquifers, Geohydrology, St. Johns River Water Management District.

This map shows the potentiometric surface of the Upper Floridan aquifer in the St. Johns River Water Management District and vicinity for September 1985. The Upper Floridan aquifer is the principal source of potable water in the area. Water level measurements were made on approximation. mately 1,000 wells and on several springs. The potentiometric surface is shown mostly by 5-foot contour intervals. In the Fernandina Beach area of contour intervals. In the Pernandina Beach area of Nassau County, a 40-foot interval is used to show a deep cone of depression. The potentiometric surface ranged from 130 feet above sea level in Polk face ranged from 130 feet above sea level in Polk County to 91 feet below sea level in Nassau County. Water levels in key wells were mostly about 1 foot below average for September but were trending upward in response to the rainfall that broke the drought-like dry season. Most levels in the district were below the levels of September 1984. Declines of 3 to 5 feet from September 1984 levels were common in the midwestern part of the district. However, most September 1985 levels ranged from 2 to 7 feet above those of May 1985. (USGS)
W87-09838

ALTITUDE AND CONFIGURATION OF THE WATER TABLE IN THE HIGH PLAINS AQUI-FER IN KANSAS, 1960, Geological Survey, Garden City, KS. Water Re-

sources Div.

M. E. Pabst, and L. E. Stullken. Available from USGS, OFSS, Box 25425, Lake-wood, CO 80225. USGS Open File Report 82-429, 1982, 1 sheet (map), 3 fig. 8 ref.

Descriptors: \*Water table, \*Potentiometric level, \*Kansas, \*Maps, Groundwater, Unconfined aquifers, Underflow, Underground storage, Wateraring formations, High Pl

The High Plains aquifer in Kansas is part of a regional aquifer system that extends into Colorado, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming. The aquifer in Kansas underlies an area of 31,000 square miles in the western and south-central part of the State. The aquifer is a hydraulically connected assemblage of unconsolidated water-bearing deposits. In western Kansas, the High Plains aquifer consists principally of the Ogallala Formation of the late Tertiary age and the overlying deposits of Quaternary age. In south-central Kansas, the aquifer consists of unconsolidated deposits principally of Quaternary age Valley alluvium of Quaternary age also is included in the deposits in both areas. The High Plains aquifer is delimited on the east by outcrops of Permian or Cretaecous rocks and by unsaturated aquifer is delimited on the east by outcrops of Permian or Cretaceous rocks and by unsaturated deposits of Quaternary age. The altitude and configuration of the water table during 1960 are shown for the High Plains aquifer in Kansas. The water table sloped generally from west to east at an average rate of 10 feet per mile. The altitude of the water table ranged from about 3,900 feet in the southwest corner of Sherman County, northwesters Kanses to about 130 feet in serthers. See ern Kansas, to about 1,350 feet in northern Sedg-wick County, southcentral Kansas. Groundwater moves perpendicular to the water table contours from higher altitudes in the western part of the High Plains to lower altitudes in the east. Contours that cross stream valleys without flexure may indicate that the water table was below the streambed. Upstream flexure of water table contours along

#### Groundwater-Group 2F

streams indicates that groundwater flowed toward, streams indicates that groundwater flowed toward, and discharged into, streams. This is most evident along the South Fork Republican River in Cheyenne County, Northwestern Kansas, and the South Fork Ninnescah River in Pratt and Kingman Counties, south-central Kansas. (USGS) W87-09839

POTENTIOMETRIC SURFACE OF THE UPPER FLORIDAN AQUIFER IN CENTRAL SUMTER COUNTY, FLORIDA, SEPTEMBER 1985, Geological Survey, Orlando, FL. Water Resources

Div

Div.
L. A. Bradner.
Available from USGS, OFSS, Box 25425, Lakewood, CO 80225. USGS Open File Report 85-681, 1985. I sheet (map).

Descriptors: \*Potentiometric levels, \*Maps, \*Florida, \*Floridan aquifer, Groundwater, Hydrologic aspects, Aquifers, Hydrogeology, Sumter County.

The map presents the potentiometric surface of the Upper Floridan aquifer in central Sumter County, Florida, for September 1985. The Upper Floridan aquifer is the principal source of potable water in riorida, for September 1985. The Upper Floridan aquifer is the principal source of potable water in the area. The focus of the map is the potentiometric surface in the Jumper Creek Canal area. Water level measurements were made on approximately 60 wells. The potentiometric surface ranged in altitude from more than 90 feet in the southeastern part of the county to less than 40 feet northwest of Lake Panasoffkee in the west-central area. (USGS) W87-09840

PRINCIPAL FACTS FOR GRAVITY STATIONS IN PARADISE AND STAGECOACH VALLEYS, HUMBOLDT AND LYON COUNTIES,

NEVADA, Geological Survey, Carson City, NV. Water Re-sources Div. For primary bibliographic entry see Field 7C. W87-09842

COMPILATION OF WELL AND GROUND-WATER QUALITY DATA FOR SELECTED WELLS NEAR BLACKFOOT, IDAHO, Geological Survey, Boise, ID. Water Resources

Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 86-127, 1986. 113 p, 7 fig, 5 tab, 7 ref.

Descriptors: \*Groundwater, \*Hydrologic data, \*Data collections, \*Groundwater levels, \*Well data, \*Water quality data, \*Idaho, Cations, Ions, Nitrogen compounds, Organic carbon, Dissolved oxygen, Heavy metals, Iron, Manganese, Zinc, Blackfoot.

Well-construction, geologic, and water level data from 1978 to 1985 were compiled for 163 sites near Blackfoot, Idaho. Groundwater quality data were compiled for 51 sites for the period 1961-83 and for 54 sites for the period 1984-85. Data were collected in support of the hydrologic and water quality components of the U.S. Geological Survey's groundwater contamination investigation near Blackfoot. Result of the investigation are presented in an interpretive report, published separately. (USGS)
W87-09843

KANSAS GROUND-WATER OBSERVATION-WELL NETWORK, 1985, Geological Survey, Lawrence, KS. Water Re-

es Div.

Sources Div.

B. J. Dague, and L. E. Stullken.

Available from USGS, OFSS, Box 25425, Denver,
CO 80225. USGS Open File Report 86-231, 1986.

52 p, 2 fig, 1 tab, 54 ref.

Descriptors: \*Hydrologic data, \*Groundwater levels, \*Data collections, \*Kansas, \*High Plains aquifer, Water measurement, Water data.

Water level measurements are made in 1,892 se-lected wells in 73 counties, which currently (1985)

comprise the Kansas groundwater observation-well network. These measurements are made on a continuous, monthly, quarterly, or annual basis. Water level measurements have been made in observation wells since 1937 as part of a cooperative program among the Kansas Geological Survey, the Kansas State Board of Agriculture, the city of Wichita, and the U.S. Geological Survey. The objectives of the observation-well cooperative program are: (1) to provide long-term records of water level fluctuations in representative wells, (2) to facilitate the determination of possible water level trends that may indicate future availability of groundwater supplies, (3) to aid in the determination of possible changes in the base flow of streams, and (4) to provide information for use in water-resources research. This report lists for each well in the network the location, the first year of recorded water level measurement, the frequency and number of measurements, the land-surface altitude, hexagon-grid identifiers for wells in the High Plains aquifer, and the principal geologic unit(a) in which the well is completed. (USGS)

SELECTED GEOHYDROLOGIC DATA FOR THE MESILLA BASIN, DONA ANA COUNTY, NEW MEXICO, AND EL PASO COUNTY, TEXAS,

ical Survey, Albuquerque, NM. Water Re

Geological Survey, Albuquerque, NM. Water Resources Div. E. Nickerson.
Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 86-75, 1986. 59 p, 35 fig, 2 tab, 4 ref, 1 plate.

Descriptors: \*Groundwater levels, \*Hydrologic data, \*New Mexico, Chemical analysis, Water level fluctuations, Well logs, Observation wells, Surface water records, Geohydrologic data, Dona Ana County, Texas, El Paso County, Mesilla Basin, Rio Grande.

In 1983, the U.S. Geological Survey began a multiphase study to help define the hydrologic system of the Mesilla Basin in Dona Ana County, New Mexico, and El Paso County, Texas. This report is a compilation of selected geohydrologic data collected through July 1985. The report describes the groundwater monitoring network of 143 wells, including 3 hydrologic sections constructed across the Mesilla Valley. Geohydrologic data presented in the report include: well records and water levels from 143 wells, chemical analyses of water samples from 143 wells, chemical analyses of water samples from 34 observation wells, borchole-geophysical logs of 10 observation wells, and river stage at 3 hydrologic sections. (USGS)

HYDROLOGIC DATA FOR THE SOUTHERN SAND HILLS AREA, NEBRASKA, Geological Survey, Lincoln, NE. Water Resources

Div.

For primary bibliographic entry see Field 2E. W87-09847

HYDROGEOLOGIC DATA FROM A 2,000-FOOT DEEP CORE HOLE AT POLK CITY, GREEN SWAMP AREA, CENTRAL FLORIDA, Geological Survey, Orlando, FL. Water Resources

Geological Survey, Orlando, P.L. water Resources Div. A. S. Navoy. Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 84-4257, 1986. 89 p, 22 fig, 6 tab, 14 ref.

Descriptors: \*Geohydrology, \*Hydrologic data, \*Florida, Groundwater, Water quality, Water levels, Aquifers, Polk County.

Two core holes were drilled to depths of 906 and 1,996 feet, respectively, within the Tertiary limestone (Floridan) aquifers, at Polk City, central Florida. Data from the two holes revealed that the bottom of the zone of vigorous groundwater circulation is confined by carbonate rocks at a depth of about 1,000 feet (863 feet below sea level). The zone of circulation is divided into two high-permeability zones. The dissolved solids of the water within the high-permeability zones is approximate-

ly 150 milligrams per liter. Within the carbonate rocks, the dissolved solids content of the water reaches about 2,000 milligrams per liter at the bottom of the core hole. Water levels in the core holes declined a total of about 16 feet as the hole was drilled; most of the head loss occurred at depths below 1,800 feet. The porosities of selected cores ranged from 1.6 to 45.3 percent; the hydraulic conductivities ranged from less than 0.000024 to 19.0786 feet per day in the horizontal direction and from less than 0.000024 to 2.99 feet per day in the vertical direction; and the ratio of vertical to horizontal permeability ranged from 0.03 to 19.8. Due contal permeability ranged from 0.03 to 198. Due to drilling problems, packer tests and geophysical logging could not be accomplished. (USGS) W87-09848

WATER RESOURCES OF LAKE AND MOODY COUNTIES, SOUTH DAKOTA,
Geological Survey, Houston, TX. Water Resources Div. For primary bibliographic entry see Field 2E. W87-09849

HYDROGEOLOGIC AND WATER-QUALITY CHARACTERISTICS OF THE CRETACEOUS AQUIFER, SOUTHWEST MINNESOTA, Geological Survey, St. Paul, MN. Water Resources Div.

For primary bibliographic entry see Field 7C. W87-09850

DESIGN, OPERATION, AND MONITORING CAPABILITY OF AN EXPERIMENTAL ARTIFICIAL-RECHARGE FACILITY AT EAST MEADOW, LONG ISLAND, NEW YORK,

Geological Sprvey, Syosset, NY. Water Reso

For primary bibliographic entry see Field 5D. W87-09851

WATER RESOURCES OF THE SOUTHEAST

Geological Survey, Rolla, MO. Water Resources

For primary bibliographic entry see Field 2E. W87-09855

WATER RESOURCES OF DEUEL AND HAMLIN COUNTIES, SOUTH DAKOTA, Geological Survey, Huron, SD. Water Resources

J. Kum Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 84-4069, 1985. 53 p, 23 fig. 7 tab, 49 ref.

Descriptors: \*Groundwater, \*Aquifers, \*Ground-water storage, \*South Dakota, Aquifer characteris-tics, Water quality, Streamflow, Deuel County, Hamlin County.

An estimated 8.5 million acre-feet of water is An estimated b.5 million acre-teet of water is stored in three major and several minor aquifers in the glacial drift in Deuel and Hamlin Counties, SD. The Big Sioux aquifer, underlying the valley of the Big Sioux River and some of its tributaries, contains an estimated 0.5 million acre-feet of water contains an estimated 0.5 million acre-feet of water in storage, but is, along with other small surficial aquifers, the most easily developed source of good-quality groundwater. These aquifers can yield enough to supply large capacity wells in many areas. The Big Sioux, and other surficial aquifers, are hydraulically connected with the Big Sioux River or other streams and some lakes in the area, so that these aquifers can receive recharge from or discharge water to those streams and lakes. The other two major aquifers in the drift are the Prairie Coteau aquifers, buried beneath 3 to 364 feet of till, and the Altamont aquifers, buried beneath 150 to 820 feet of till and commonly overlying the bedrock surface. The only known aquifer in the bedrock surface. The only known aquifer in the bedrock surface. The similated 5 million acre-feet of which contains an estimated 5 million acre-feet of which contains an estimated 5 million acre-feet of saline water. (USGS)

#### Group 2F-Groundwater

MAPS SHOWING GROUND-WATER LEVELS IN THE COLUMBIA RIVER BASALT AND OVERLYING MATERIALS, SPRING 1983, SOUTHEASTERN WASHINGTON, Geological Survey, Tacoma, WA. Water Re-

creotogical survey, 1 acoma, WA. Water Resources Div.
H. H. Bauer, J. J. Vaccaro, and R. C. Lane.
Available from USGS, OFSS, Box 25425, Denver,
CO 80225. USGS Water-Resources Investigations
Report 84-4360, 1985. 4 sheets, 2 fig, 8 ref.

Descriptors: \*Groundwater levels, \*Groundwater movement, \*Maps, \*Geohydrology, \*Washington, Recharge, Pumpage, Geology, Columbia Plateau.

A 2 1/2-year study of the Columbia Plateau in A 2 1/2-year study of the Columbia Plateau in Washington was begun in March 1982 to define spatial and temporal variations in dissolved sodium in aquifers of the Columbia River Basalt Group and to relate these variations to the groundwater system and its geologic framework. This report is part of that study and describes groundwater level contours for four major geohydrologic units in southeastern Washington, constructed from waterlevel data collected from approximately 1,100 wells during the spring of 1983, data from U.S. Geological Survey studies in the area, and other indirect methods. Configuration of the groundwater level contours is controlled by: (1) extent of a geohydrologic unit and geologic structure, (2) recharge from precipitation and surface water bodies, (3) rivers, lakes, and coulees that drain the groundwater system, and (4) hydraulic conductivbodies, (3) rivers, lakes, and coulees that drain the groundwater system, and (4) hydraulic conductiv-ities of each unit. Upgradient flexures of water level contours north of Connel, Washington, show effects of prolonged irrigation while downgradient flexures in an area south of Potholes Reservoir, in the vicinity of the East Low Irrigation Canal, show the effects of increased man-induced re-charge. (USGS) W87-09858

GEOHYDROLOGY OF THE GLACIAL-OUTWASH AQUIFER IN THE BATAVIA AREA, TONAWANDA CREEK, GENESEE COUNTY, NEW YORK, Geological Survey, Ithaca, NY. Water Resources

D. B. Terry, T. S. Pagano, and A. W. Ingram.
Available from USGS, OFSS, Box 25425, Denver,
CO 80225. USGS Water-Resources Investigations Report 84-4096, 1986. 7 sheets (maps), 7 fig, 6 ref.

Descriptors: \*Aquifers, \*Groundwater movement, \*New York, \*Maps, \*Geohydrology, Infiltration capacity, Land use, Well yield, Groundwater levels, Genesee County, Soil permeability, Groundwater.

The Batavia glacial-outwash aquifer, composed of outwash, kame, and alluvial sand and gravel, is highly productive and is partly in hydraulic con-tact with Tonawanda Creek. Potential well yields range from 50 to more than 1,000 gallons per minute. Most of the aquifer is under shallow water range from 30 mote min 1,000 gains per minute. Most of the aquifer is under shallow water table conditions and vulnerable to surface contamination. Aquifer thickness ranges from 10 to 60 feet. The aquifer underlies a mostly rural area containing only small communities and, therefore, is not heavily pumped. Geohydrologic data are compiled on six maps at 1:24,000 scale and in geologic sections. The maps depict surficial geology, soil-infiltration capacity, potentiometric surface, aquifer thickness, well yields, and land use. This map report is one in a series of four that depict selected aquifers in western New York. It supplements a series that is being done by the U.S. Geological Survey in cooperation with State agencies. The maps are based largely on published reports, data filed in several State agencies, and field notes. (USGS) (USGS) W87-09859

EFFECTS OF INCREASED PUMPAGE ON A FRACTURED-BEDROCK AQUIFER SYSTEM IN CENTRAL ORANGE COUNTY, NEW YORK, Geological Survey, Albany, NY. Water Resources

M. Garber.

Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations

Report 84-4348, 1985. 27 p, 13 fig, 3 tab, 20 ref.

Descriptors: \*Aquifers, \*Potentiometric level, \*New York, Groundwater, Bedrock, Observation wells, Storage, Transmissivity, Withdrawal, Pump-age, Orange County, Geophysical logging, Faults.

age, Orange County, Geophysical logging, Faults.

The bedrock in central Orange County consists of highly indurated silistone, shale, and conglomerate containing two major fault systems and extensive fracturing; it is overlain by 50 to 100 feet of till. The fracturing permits unusually high well yields. Wells tapping the bedrock yield 75 to 200 gallons per minute; those tapping bedrock in adjacent areas yield only a few tens of gallons per minute. The bedrock aquifer is recharged mainly by percolation of water from precipitation through the till. In 1983, the U.S. Geological Survey studied the hydrologic effects of increased pumpage on the fractured bedrock aquifer system near the Village's two well fields from February to October 1983, and pumpage data from the same period were tabulated. Water levels responded to variations in both pumpage and precipitation. Pumping tests and water levels in the southeastern well field. An observation well between the two fields shows about 20 feet of seasonal fluctuation from recharge and the effects of pumping at the northwestern well field. Aquifer-test data indicate a transmissivity of 900 feet squared per day and a storage coefficient of 0.0001. (USGS)

QUALITY OF WATER IN THE PRINCIPAL AQUIFERS OF SOUTHWESTERN WASHINGTON,

Geological Survey, Tacoma, WA. Water Resources Div. For primary bibliographic entry see Field 5B. W87-09862

POTENTIOMETRIC MAP OF THE LOWER WILCOX AQUIFER IN MISSISSIPPI, FALL

Geological Survey, Jackson, MS. Water Resources

Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 85-4059, 1986. 1 sheet (map), 3 fig, 3 ref.

Descriptors: \*Water levels, \*Potentiometric level, \*Maps, \*Mississippi, Groundwater, Aquifers, Wilcox Group, Wilcox aquifer.

This potentiometric map is the second map of the lower Wilcox aquifer in a series of maps prepared by the U.S. Geological Survey in cooperation with the Mississippi Department of Natural Resources, Bureau of Land and Water Resources, delineating the potentiometric surface of the major aquifers in Mississippi. The potentiometric surface of the lower Wilcox aquifer slopes generally to the west away from the outcrop area and it is marked by a large groundwater cone of depression in the area of Tallahatchie, Quitman, and Panola Counties. Water levels in or near the outcrop of the lower Wilcox aquifer show little longterm change. Heavy withdrawals in the downdip area have caused water level declines of about 1 to 2 feet per year since 1979 in much of the confined part of the aquifer. These water level declines in the area of Tallahatchie, Quitman, and Panola Counties have resulted in a wider cone of depression since 1979. (USGS) resulted (USGS)

PLAN OF STUDY FOR THE REGIONAL AQ-UIFER-SYSTEM ANALYSIS OF THE COLUM-BIA PLATEAU, WASHINGTON, NORTHERN OREGON, AND NORTHWESTERN IDAHO, Geological Survey, Tacoma, WA. Water Resources Div. J. J. Vaccaro.

Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 85-4151, 1986. 25 p, 5 fig. 15 ref.

Descriptors: \*Aquifer systems, \*Columbia Plateau, \*Washington, \*Regional Aquifer-System Analysis (RASA), Aquifer characteristics, Aquifer management, Computer models, Columbia River Basalt

The U.S. Geological Survey began a 4-year study of the regional aquifer system underlying the Columbia Plateau, in central and eastern Washington, northern Oregon, and northwestern Idaho in October 1983, as part of the Regional Aquifer System Analysis program. The study will describe the geohydrology, geochemistry, and quality of water in the Columbia River Basalt Group, the Miocene rocks that underlie 70,000 square miles in three States. Water from the basalts is used for municipal and industrial purposes, and most importantly, for agriculture. As more land is brought under cultivation and surface water becomes totally allocated. agriculture. As more land is brought under cultiva-tion and surface water becomes totally allocated, the groundwater is an increasingly important supply for agriculture and related activities. In addition, the basalts are being considered as a repository site for high-level nuclear wastes. For management agencies to make the best decisions regarding the future development of this area, the regional groundwater flow system, its relation to the surfacewater system, and the quality of the water need to be quantified. This report describes the geohydrologic setting, hydrologic problems, objectives, and approach for the region. (USGS) W87-09865

SUMMARY OF HYDROLOGIC INFORMATION FOR THE DENVER COAL REGION, COLORADO,

Geological Survey, Lakewood, CO. Water Resources Div. For primary bibliographic entry see Field 7C. W87-09866

NEW CONCEPT TO DESCRIBE FLOW THROUGH POROUS MEDIA,

Technical Univ. of Heavy Industry, Miskolc (Hungary). Dept. of Geomechanics. E. Bobok.

In: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volume II, 1984. SIAMOS 78. p 693-706, 1 fig. 7

Descriptors: \*Groundwater movement, \*Porous media, \*Flow discharge, \*Mathematical equations, Mathematical studies, Pores, Velocity distribution, Stochastic process

A new treatment of groundwater flow is introduced. While the velocity distribution in the pores is always changing stochastically, the mean values show regularity. The velocity field of the flow through porous media is assumed to be a mean velocity field with fluctuation about the mean superimposed on it. From this the equation of motion can be derived. (See also W87-09568) (Author's abstract) W87-09868

USES OF MATHEMATICAL MODELS FOR THE PREDICTION OF WATER INFLOWS IN MINING WORKS (UTILISATION DE MO-DELES MATHEMATIQUES POUR LA PREVI SION DES VENUES D'EAU EN TRAVAUX

MINIERS),
Societe Centrale pour l'Equipment du Territoire,
Montigny (France).
A. Bonnier, and A. Korganoff.
IN: Water in Mining and Underground Works (El
Agua en la Mineria y Trabajos Subterraneos),
Agua en II, 1984. SIAMOS 78. p 707-717, 2 fig.

Descriptors: \*Drainage engineering, \*Mine drainage. \*Groundwater, \*Dewatering, \*Model studies, Mathematical models, Mathematical equations, Groundwater movement, Mining engineering, nulation, Pumpage, Quarries.

Estimating the inflow of groundwater in mine works is made especially difficult by the variability of the geometrical characteristics of these structures and by the need for dewatering the waterbearing horizons. Mathematical models which sim-

#### Groundwater-Group 2F

ulate groundwater flow generally help to determine to a satisfactorily accurate degree the rates of inflow of the water to be drained and their variations. A comparison of the probable rates of inflow provided by this type of model and the real pumpage volumes is presented first in the case of a quarry and second in the case of a mine shaft. (See also W87-09568) (Author's abstract) W87-09869

METRO' IN LYON, FRANCE. CONSTRUCTION BELOW THE WATER TABLE (METRO DE LYON, CONSTRUCTION SOUS LE NIVEAU DE LA NAPPE PHREATIQUE), Societe d'Economie Mixte du Metropolitain de l'Agglomeration Lyonaise (France). For primary bibliographic entry see Field 4B. W87-09870

DRAINAGE OF A MINE TO A CONSTANT LEVEL (DRENAJE DE UNA MINA HASTA NIVEL CONSTANTE), Granada Univ. (Spain). Dept. de Quimica Inorgan-

For primary bibliographic entry see Field 4B. W87-0987i

SYSTEMS APPROACH FOR MINE WATER CONTROL, Mining Development Central Inst., Budapest

For primary bibliographic entry see Field 4B. W87-09874

MATHEMATICAL SIMULATION OF HY-DRAULIC NETWORK TO DRAIN MINE AND CONSTRUCTION WORK,

Geotest Brno (Czechoslovakia).

M. Loupanec.
In: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volume II, 1984. SIAMOS 78. p 805-823, 3 fig, 21

Descriptors: \*Drainage systems, \*Model studies, \*Mine drainage, \*Drainage, \*Groundwater, \*Model studies, \*Simulation, \*Mathematical equations, Mathematical equations, Mathematical models, Mathematical equations, Mathematical studies, Statistical methods, Differential equations,

The aspects of well-network optimization in design of drainage systems for mines or construction work are discussed. Optimization of well networks is solved by means of mathematical simulation. Stochastic models starting from methods of mathematical statistics and probability give data for the final deterministic model described by partial differential equations for physically defined aquifers. The requirements for hardware and software for the computerized system are presented. (Authors abstract)

SEEPAGE CHARACTERISTICS THROUGH AN ABANDONED TAILINGS PILE, Idaho Univ., Moscow. For primary bibliographic entry see Field 5B.

UNDERGROUND MINE DRAINAGE QUANTI-TY AND QUALITY GENERATION MODEL, Ohio State Univ., Columbus. Dept. of Civil Engineering. For primar W87-09878 nary bibliographic entry see Field 5B.

AQUIFER PARAMETER IDENTIFICATION BY USING DIGITAL SIMULATION MODELS, Water Resources Directorate, Punjab (India). R. K. Sabherwal, S. P. Rajagopalan, and V. akshminarayana

Lakshiningarayana.

In: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volume II, 1984. SIAMOS 78. p 899-910, 2 fig, 1

Descriptors: \*Aquifer characteristics, \*Ground-water movement, \*Aquifer parameters, \*Ground-water, \*Model studies, \*Unsteady flow, \*Radial flow, \*Data interpretation, Simulation, Digital models, Flow characteristics, Anisotropy, Aquifer testing, India, Permeability, Specific retention, Specific yield, Partially penetrating wells.

A digital model simulating unsteady-state radial flow to partially penetrating wells in unconfined anisotropic aquifers is applied to analyze test-data from an aquifer test carried out in the alluvial plains of Northern India. The parameters identified are the lateral permeability, anisotropy, specific storage and specific yield of the aquifer. Complex aquifer conditions can be simulated by digital models. It requires fewer observation wells for a digital model than for analytical methods. (See also W87-09568) (Author's abstract)

REDUCING WATER LEAKAGE INTO UNDER-GROUND COAL MINES BY AQUIFER DEWA-

Argonne National Lab., IL. Energy and Environ-mental Systems Div. For primary bibliographic entry see Field 4B. W87-09881

DRAINAGE AND STABILITY PROBLEMS OF TALUSES IN AN OPEN PIT EXCAVATION IN MARQUESADO (PROBLEMES D'EXHAURE ET STABILITE DES PENTES DANS LA MINE A CIEL OUVERT DU MARQUESADO), Ecole Nationale Superieure des Mines de Paris Carlos (Problemes de

Ecole Prancis. (France). C. Streiff, and G. Ricci. IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterrancos), Volume II, 1984. SIAMOS 78. p 933-949, 14 fig, 6

Descriptors: "Aquifers, "Groundwater management, "Groundwater, "Drainage engineering, "Stability analysis, "Model studies, "Data interpretation, Iron-ore excavation, Marquesado, Spain, Alluvions, Mathematical models, Drying, Economic

In the open pit-mine of Marquesado (Spain), the iron-ore is extracted from a lens of limestone, buried under alluvium, the depth of which reaches 200 meters, and which contains an aquiferous 200 meters, and which contains an aquiferous sheet. The presence of water under the alluvial slopes is very bad for their stability. In order to find a practical means of drying the alluvium, a mathematical model of the aquiferous sheet in a wide field around the pit was developed. It was then used to study the stability of the alluvial slopes in the presence of water to determine if, from an economic point of view, it was better to dry the alluvial and approach to the content of t from an economic point of view, it was better to dry the alluvium at any cost or to give up drying but to reduce the slopes and to remove alluvium. (See also W87-09368) (Author's abstract) W87-09882.

APPLICATION OF A SIMULATION MODEL FOR A LARGE-SCALE KARSTIC WATER AQ-

Development Central Inst., Budapest Mining

Mining Development (Hungary). G. Szilagyi, Z. Heinemann, and I. Bogardi. IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volume II, 1984. SIAMOS 78. p 951-964, 6 fig. 17

Descriptors: "Aquifers, "Mine drainage, "Drainage engineering, "Karst, "Groundwater, "Groundwater management, "Model studies, "Data interpretation, "Simulation, Mine drainage, Water management, Flow discharge, Finite difference method, Mathematical models, Mathematical studies, Mathematical equations, Unsteady flow, Alternative

Mining activity, water management and the environment are interrelated in a regional karstic aquifer. A proper operation of existing works and their optimal development requires the knowledge of

water movement. A simulation method is based on a finite difference solution of the two-dimensional, unsteady flow equation. Inputs of the model are rainfall over the area and water intakes at different points. Output yields the piezometric heights in grid points, and system outflow. The simulation model can be connected to a decision model which helps to choose the best alternatives for mine water management, water supply and environmental protection. (See also W87-09568) (Author's abstract) W87-09883

ELEMENT BALANCE METHOD OF HYDRO-GEOLOGIC COMPUTATION, Hydrogeologic Co. of the Ministry of the Metal-lurgical Industry, Beijing (China). H. Wu.

H. Wu. In: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volume II, 1984. SIAMOS 78. p 965-970, 5 fig. 1

Descriptors: \*Groundwater, \*Unsteady flow, \*Groundwater hydrology, \*Groundwater movement, \*Element balance method, \*Model studies, \*Numerical analysis, \*Data interpretation, Vadose water, Hydrologic budget, Mathematical studies, Mathematical equations, Mathematical models, Differential equations.

The element balance method is one of the numerical methods for solving the problem of planned non-steady flow of groundwater. The vadose region is divided into several elements by this method and then, based on the water balance theory, the equations of every node are set up directly using a physical model. The solution of the two-dimensional partial differential equation of groundwater flow is described using a discrete equation group which contains only limited numbers of unknown variables. The presented method has the advantage over other numerical methods because its clear physical concepts are easily mastered by engineering technicians. It may also avoid disturbing the local quality balance and circumvents the limitations imposed by the selected time intervals in the finite element method. The application of this method gives hydrogeologic paramitors. intervas in the mine termine interior. I reapplica-tion of this method gives hydrogeologic param-eters, predicts the mine drainage, and also esti-mates the groundwater resource with good results. (See also W87-09568) (Wood-PTT) W87-09888.

COMPUTER ANALYSIS OF WATER PUMP IN THE LLANO MINE (TERUEL, SPAIN) (ANALI-SIS POR ORDENADOR DE LOS BOMBEOS EN LA MINA LLANO (TEREUL-ESPANA)), Granada Univ. (Spain). Grupo de Trabajo de Hi-

drogeologia.
A. Yague Ballester, and R. Fernandez-Rubio.
IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterrancos), Volume II, 1984. S1AMOS 78. p 971-988, 4 fig. 4 tab, 16 ref.

Descriptors: \*Mine drainage, \*Pumping, \*Ground-water, \*Ground-water movement, \*Computer pro-grams, \*Data interpretation, \*Ground-water management, Computers, Fortran, Drainage, Llano Mine, Spain, Water level, Piezometers, Mathemati-cal equations, Jacob simplification, Iron mines.

ate analysis of the piezometric lowering pro-Adequate analysis of the piezometric lowering pro-duced during a long pumping period is influenced by many factors including lithological heterogene-ities, impervious boundaries, constant head bound-aries, yield exchange and variations of transmissi-vity with time. To facilitate the analysis, a method of computer calculation was developed, starting from the Jacob simplification and the ratio method, which increases the application possibilities and avoids the routine calculations. The FORTRAN code and an example of the application to the drainage of the future iron mine of Llano (Teruel) are presented. (See also W87-09568) (Author's abstract) W87-09885

GROUNDWATER HYDROLOGY - A TOOL FOR MINE PLANNING, OPERATION AND ABANDONMENT.

#### Group 2F-Groundwater

Idaho Univ., Moscow. Coll. of Mines and Earth For primary bibliographic entry see Field 4B. W87-09891

HOT WATER IN UNDERGROUND MINING, Washington Univ., Seattle. Dept. of Mining, Met-allurgical, and Ceramic Engineering. Anderson

In: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol-umes I and II, 1984. SIAMOS 78. p 1111-1123, 7 fig, 7 ref.

Descriptors: \*Mine drainage, \*Mining engineering, \*Thermal water, \*Drainage engineering, \*Under-ground structures, Central America, Hazards, Safety, Water level, Drainage, Pumping.

The case history of an underground mine in Central America with water of volcanic origin having a maximum temperature of 77 C was discussed. Hot water in underground mines causes disagree-able working conditions and high costs due to decreased efficiency and necessary increased ventiation. With advanced planning, the problem can be handled by sinking initial openings either in hanging or footwall formations depending on which is more impervious. From the impervious host rock, bottomed below the lowest operating level, crosscuts or drill holes can tap hot water and special pumping techniques can lower the water level and drain the orebody. The methods of controlling the hot water and working under the adverse conditions were detailed. (Wood-PTT)

GROUNDWATER PROBLEMS IN THE MINING DISTRICT OF IGLESIENTE (SAR-DINIA, ITALY), Politecnico di Torino (Italy). Ist. di Giacimenti Minerari e Geologia Applicata. For primary bibliographic entry see Field 4B. W87-0985

DRAINAGE IN SPANISH MINING (EL DESA-GUE EN LA MINERIA ESPANOLA), Rios Rosas, Madrid (Spain).
For primary bibliographic entry see Field 4B.
W87-09896

WATER-ADIT GALLERIES IN THE VOLCAN-WATER-ADIT GALLERIES IN THE VUICAN-IC MASSIF OF FAMARA (LANZAROTE, CANARY ISLAND) (LAS MINAS DE CAPTA-CION DE AGUA EN EL MACIZO VOLCANICO DE FAMARA (LANZAROTE, ISLAS CANAR-

Comisaria de Aguas del Pirineo Oriental, Barcelona (Spain).

For primary bibliographic entry see Field 4B. W87-09897

DRYING UP THE LIMONITIC MINERAL IN THE SIERRA MENERA MINES (TERUEL AND GUADALAJARA, SPAIN) (SECADO DEL MINERAL LIMONITICO DE LOS YACIMIENTOS DE LA SIERRA MENERA (TERUEL Y GUADA-LAJARA, ESPANA)), Granada Univ. (Spain). Grupo de Trabajo de Hi-

drogeologia.

orogeologia. R. Fernandez-Rubio, and J. L. Sastre. IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol-umes I and II, 1984. SIAMOS 78. p 1207-1224, 8 fig. 2 tab. 10 ref.

Descriptors: \*Mine drainage, \*Groundwater, \*Iron ore mining, \*Moisture content, Iron, Heavy metals, Sierra Menera mines, Spain, Drainage, Pumping, Groundwater hydrology.

The iron ore mined in the 'Ojos Negros' mines retains a certain quantity of moisture, despite on the spot drainage by means of pumping in boreholes. This moisture can cause problems in the manipulation and treatment of the ore. The percentages of the different types of water content (retention, capillary and gravity) were studied in

different hydrogeological conditions of the ore deposit: below and above the original water level; before and after drainage in the mines; and in areas exposed to the air. Several standardized series of experiments conducted on industrial scale were described. The effects on the moisture content of described. The effects on the moisture content or removal of the mineral, pile depth, and orientation were analyzed with respect to wind, sun radiation, atmospheric pressure, rainfall, temperature and rel-ative humidity of the air. (Author's abstract)

DEEP DEPRESSION OF THE PIEZOMETRIC LEVEL IN THE THERMAL SPRING OF TE-PLICE (NORTHWESTERN BOHEMIA, CZECHOSLOVAKIA), DUE TO OPEN PIT EX-CAVATION OF LIGNITE (L'ABAISSEMENT PROFOND DU NIVEAU PIEZOMETRIQUE DES SOURCES THERMALES DE TEPLICE (NORD-OUEST DE LA BOHEME, TCHESCOS-LOVAQUIE) AU COURS DE L'EXPLOITA-TION DE LIGNITE A CIEL OUVERT), Vysoka Skola Banska, Ostrava (Czechoslovakia). For primary bibliographic entry see Field 4B. W87-09901

IMPLICATIONS OF GRAVEL EXTRACTION ON GROUNDWATER CONDITIONS. Birmingham Univ. (England). Dept. of Geological

For primary bibliographic entry see Field 4C. W87-09902

GROUNDWATER PROBLEMS CAUSED BY EXCAVATION OF BUILDING BASEMENT FROM THE VIEWPOINT OF NATURE CON-

Tohoku Univ., Sendai (Japan). For primary bibliographic entry see Field 4C. W87-09904

WATER CAPACITY OF ABANDONED WORK-INGS IN UNDERGROUND COAL MINES, Glowny Inst. Gornictwa, Katowice (Poland). For primary bibliographic entry see Field 4B. W87-09905

DETERMINATION OF THE TRANSMISSI-VITY OF COASTAL AQUIFERS BASED ON THE OBSERVATION OF SINUSOIDAL, ON-DULATORY, TRANSITORY REGIMES IN-DUCED BY TIDAL OSCILLATIONS, INTEC GENERAL MICE, 120 Medial France

INITEC, General Mola, 120, Madrid, Espana. L. Ucero Aoiz, and S. Uriel Romero. IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol-umes I and II, 1984. SIAMOS 78. p 1303-1322, 12 fig, 2 ref.

Descriptors: \*Coastal aquifers, \*Transmissivity, \*Data interpretation, \*Mathematical equations, \*Oscillatory waves, \*Tidal effects, Dewatering, Tidal hydraulics, Harbors, Sea level, Water level, Pumping, Damping effects, Mathematical studies.

It is not infrequent to find that work to be carried out in harbors and shipyards demands large-scale evacuation to dry conditions below sea level. The evacuation to dry conditions below sea level. The pumping operations required in the course of the execution or development of the work often dictate the nature of the construction process and its typology. An attempt is made to develop a method for ascertaining the transmissivity of the terrain affected by the excavation, on the basis of the damping effects or time-lag with which the oscillation of the tide is transmitted through the filtering media. This method, which was initially developed by Ferris for one-way propagation in homogeneby Ferris for one-way propagation in homogene-ous terrain, is now extended to cover more frequent, irregular situations where such propagation is bi-directional. (Author's abstract)
W87-09906

URANIUM AND RARE EARTH ELEMENTS IN C02-RICH WATERS FROM VALS-LES-BAINS

Centre de Recherches Petrographiques et Geochi-

miques, Nancy (France). For primary bibliographic entry see Field 2K. W87-09930

CORRELATION OF GEOLOGIC STRUCTURE INFERRED FROM COMPUTER ENHANCED LANDSAT IMAGERY WITH UNDERGROUND WATER SUPPLIES IN ARIZONA, Arizona Univ., Tucson. Office of Arid Lands Stud-

For primary bibliographic entry see Field 7B. W87-10005

LANDSAT DATA FOR LOCATING SHALLOW GLACIAL AQUIFERS IN EASTERN SOUTH

DAKOTA,
South Dakota School of Mines and Technology,
Rapid City. Dept. of Geology and Geological Enering. For primary bibliographic entry see Field 7B. W87-10006

HYDROGEOLOGIC INTERPRETATIONS OF LANDSAT IMAGERY IN ARID ZONES OF SOUTH AND WEST AFRICA,

Bundesanstalt fuer Geowissenschaften und stoffe, Hanover (Germany, F.R.). For primary bibliographic entry see Field 7C. W87-10007 schaften und Roh-

GROUND WATER EXPLORATION PROGRAMS IN AFRICA,

Earth Satellite Corp., Chevy Chase, MD. L. Zall, and O. Russell. In: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 416-425, 5 fig. 1 tab, 12

Descriptors: \*Groundwater potential, \*Africa, \*LANDSAT, \*Remote sensing, \*Tanzania, \*Upper Volta, \*Benin, \*Ghana, \*Maps, \*Hydrology, \*Satellite technology, Data interpretation, Groundwater availability, Photography, Geohydeology.

As part of regional groundwater exploration programs sponsored by the U.S. Agency for International Development (AID) in the African countries of Tanzania, Upper Volta, Benin, and Ghana, groundwater exploration guidemaps were prepared using digitally processed and photographically enlarged LANDSAT imagery. Digital processing of LANDSAT data permits the enhancement of sectral gray levels or subtle tonal varieties. essing of LANDSAT data permits the enhance-ment of spectral gray levels or subtle tonal vari-ations, such as those caused by lithologic changes, geologic structure, or varying soil moisture. Such imagery also emphasizes linear features, fractures, or faults that can be missing or difficult to interpret from unprocessed imagery. These groundwater ex-ploration guidemaps substantially increased the ef-ficiency of operation and decreased the time and expense necessary to complete these programs. Wells located on fractures or faults and especially at fracture or fault intersections, have hisber yields expense necessary to compiete these programs. Wells located on fractures or faults and especially at fracture or fault intersections, have higher yields than wells located elsewhere. Therefore, satellite imagery has mapped lineaments representing fractures and faults, as well as permeable rock lithologies favorable to groundwater accumulation. The combination of this information with available geologic, topographic, and hydrologic data resulted in the reconnaissance level groundwater exploration guidemaps. Further investigated are 'target' areas, which were delineated on the satellite imagery, with the use of existing stereo aerial photographs and available geophysical data to map in greater detail favorable rock aquifers and fracture zones. Hydrogeologists from the participating countries will field check for exploratory drilling and well placement those 'targets' identified from the aerial photographs. (See also W87-09953) (Author's abstract) W87-10008

APPLICATIONS OF AEROSPACE DATA FOR DETECTION OF SUBMARINE SPRINGS IN JAMAICA.

Lakes-Group 2H

Geological Survey, Woods Hole, MA. Water Re-For primary bibliographic entry see Field 7B. W87-10010

GROUND WATER APPLICATIONS OF THE HEAT CAPACITY MAPPING MISSION, South Dakota State Univ., Brookings. Remote Sensing Inst.

J. L. Heilman, and D. G. Moore.

IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 446-449, 5 fig. 4 ref. NASA Contract No. NASS-24206 and USGS Contract No. 14-08-0001-12510.

Descriptors: \*Groundwater, \*Subsurface mapping, \*Heat capacity method, \*Hydrologic data, \*Hydrology, \*Mapping, \*Satellite technology, \*Water table, \*Remote sensing, Radiometry, Geohydrology, Soil water

logy, Soil water.

Results of ground, aircraft, and satellite investigations are presented that demonstrate the potential for using data from NASA's Heat Capacity Mapping Mission (HCMM) satellite to provide information on perched water tables. The satellite, which carries a two-channel radiometer (0.5 to 1.1 and 10.5 to 12.5 micron) in a sun synchronous orbit, collects data at approximately 0230 and 1330 local standard time with repeat coverage of 5 or 16 days depending on latitude. Perched water tables influence surface and subsurface soil temperatures because of a heat sink effect created by the high heat capacity of water. HCMM data acquired at appropriate periods of the diurnal and annual temperature cycle can provide useful information on shallow groundwater. Hydrologic interpretations of HCMM data are complicated by thermal inertia heat sink interactions, vegetation, evapotranspiration, topography, atmospheric absorption, and other environmental variables such as solar radiation, temperature, wind, etc. (See also W87-09953) (Author's abstract)

SATELLITE OBSERVATIONS OF A GEO-THERMAL SUBMARINE SPRING OFF FLORI-DA WEST COAST, Geological Survey, Woods Hole, MA. Water Re-

sources Div. For primary bibliographic entry see Field 7B. W87-10026

#### 2G. Water In Soils

EVALUATING POTENTIAL GROUNDWATER CONTAMINATION FROM CONTAMINATED SOILS, Murray State Univ., KY.

For primary bibliographic entry see Field 5B. W87-09754

USING TIME DOMAIN REFLECTOMETRY TO MEASURE FROST DEPTH AND FROZEN WATER CONTENT IN SOIL, Washington State Univ., Pullman. Dept. of Agron-omy and Soils.

For primary bibliographic entry see Field 7B. W87-09795

RELIABILITY AND THE FACTOR OF SAFETY DUE TO PIPING, Purdue Univ., Lafayette, IN. School of Civil Engi-

neering.
M. E. Harr, and D. J. Sipher.
IN: Water in Mining and Underground Works (El
Agua en la Mineria y Trabajos Subterraneos),
Volume II, 1984. SIAMOS 78. p 775-788, 7 fig, 3 tab. 4 ref.

Descriptors: \*Piping, \*Soil mechanics, \*Computer models, \*Data interpretation, Model studies, Computers, Safety, Permeability coefficient, Finite element method, Mathematical studies, Mathematical equations, Soil physical properties.

A hybrid finite element program describing soil water movement was used to evaluate the effect of randomness and uncertainty of the coefficient of permeability on the exit hydraulic gradient. A lognormal distribution was used to assign permeabilities to the elements of the finite element grid. It ties to the elements of the finite element grid. It was found that the distribution of exit gradients could be approximated by a normal distribution having a mean value approaching that of a perfective homogeneous soil. An upper bound of the coefficient of variation of the true exit gradient was obtained from a 99% confidence interval of the chi-square distribution. This coefficient of variation was used with the theoretical solution of confined sheet pile flow to determine the probability of soil piping which corresponds to an exit gradient greater than 1.0. (See also W87-09568) (Author's abstract) ent greater that thor's abstract)

CONCERNING THE RELATIONSHIP BETWEEN EVAPOTRANSPIRATION AND SOIL MOISTURE,

National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. For primary bibliographic entry see Field 2D. W87-09910

SOIL MOISTURE ESTIMATION USING GOES-VISSR INFRARED DATA: A CASE STUDY WITH A SIMPLE STATISTICAL MODEL. National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. For primary bibliographic entry see Field 7B. W87-09913

GENE TRANSFER AMONG BACTERIA IN SOIL AND AQUATIC ENVIRONMENTS: A

Guelph Univ. (Ontario). Dept. of Environmental Biology. ary bibliographic entry see Field 2H. For primar W87-09931

SURVEY OF IN-SITU AND REMOTE SENSING METHODS FOR SOIL MOISTURE DETERMI-

NATION,
National Aeronautics and Space Administration,
Greenbelt, MD. Goddard Space Flight Center.
T. J. Schmugge, T. J. Jackson, and H. L. McKim.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 333-352, 13 fig, 2 tab, 150

Descriptors: \*Remote sensing, \*Soil water, \*Data acquisition, Infrared imagery, \*Hydrology, \*Satellite technology, Electromagnetic waves, Precipitation, Evapotranspiration, Model studies.

With increased interest in soil moisture information for applications in such disciplines as hydrology, meteorology and agriculture, an overview is needed of both existing and proposed methods for soil moisture determination. This paper discusses the methods of in-situ soil moisture determination including gravimetric, nuclear, and electromagnetic techniques; remote sensing approaches that use the reflected solar, thermal infrared, and microwave portions of the electromagnetic spectrum; and soil physics models that track the behavior of water in the soil in response to meteorological inputs (precipitation) and demands (evapotranspiration). The capacities of these approaches to satisfy various user needs for soil moisture information varies from application to application, but a conceptual scheme for merging these approaches into integrated systems to provide soil moisture information is proposed that has the potential for meeting various application requirements. (See also W87-09953) (Author's abstract)

CHARACTERISTICS OF MICROWAVE EMIS-CHARACTERISTICS OF MICROWAVE ESTION OF SIGNIFICANCE TO SATELI REMOTE SENSING OF SOIL WATER, Texas A and M Univ., College Station. Ret

Sensing Center. For primary bibliographic entry see Field 7B. W87-10001

POTENTIAL APPLICATION OF SATELLITE RADAR TO MONITOR SOIL MOISTURE, Kansas Univ./Center for Research, Inc., Lawrence. Remote Sensing Lab. For primary bibliographic entry see Field 7B. W87-10002

SOIL MOISTURE APPLICATIONS OF THE HEAT CAPACITY MAPPING MISSION, South Dakota State Univ., Brookings. Remote Sensing Inst. For primary bibliographic entry see Field 7C. W87-10003

REQUIREMENTS OF SPACE-BORNE MICRO-WAVE RADIOMETERS FOR DETECTING SOIL MOISTURE CONTENTS, Environmental Research and Technology, Inc., Concord, MA For primary bibliographic entry see Field 7B. W87-10004

#### 2H. Lakes

SELECT: A NUMERICAL, ONE-DIMENSION-AL MODEL FOR SELECTIVE WITHDRAWAL, Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab. For primary bibliographic entry see Field 5G. W87-09631

DEPENDENCE OF SUMMER PLANKTON IN-DICES ON CONTENT OF BIOGENIC ELE-MENTS IN SMALL LAKES OF LATGALL WITH VARYING LEVELS OF ANTHROPO-GENIC EUTROPHICATION, Akademiya Nauk SSSR, Leningrad. Inst. Ozerove-

For primary bibliographic entry see Field 5C. W87-09678

POLYCHLORINATED BIPHENYL DECHLOR-INATION IN AQUATIC SEDIMENTS, General Electric Co., Schenectady, NY. Research and Development Center. For primary bibliographic entry see Field 5B. W87-09681

FREQUENCY SHORT GRAVITY-CAPILLARY WAVES OB-TAINED FROM TEMPORAL MEASURE-MENTS OF WAVE HEIGHT ON A LAKE, Washington Univ., Seattle. Dept. of Atmospheric

Sciences.
S. S. Atakturk, and K. B. Katsaros.
Journal of Geophysical Research (C) JGRCEY,
Vol. 92, No. 5, P 5131-5141, May 1987. 17 fig. 1
tab, 42 ref. ONR Contract N00014-81-K-0095,
NASA Grants NAGW-303 and UPN-161-85-60-

Descriptors: \*Intrinsic frequency spectra, \*Waves, \*Lakes, \*Hydrodynamics, Winds, Currents, Velocity, Estimating, Drift.

Intrinsic frequency spectra of water waves in the range of 6-17 Hz were obtained as a function of both wind speed and wind stress from point measurements of wave height. In a lake with a limited urements of wave height. In a lake with a limited fetch there are two types of surface motions causing Doppler shift in the frequencies of short waves: orbital velocity of long waves and surface wind drift. The former was estimated from long-wave amplitude by using a linear wave theory. The error in this estimate is of the order of the long-wave slope, and for this work it is typically 10%. The latter was approximated by the friction velocity. The friction velocity could be either taken as 3% of the mean wind speed measured at a height of 10 m or obtained from our direct measurements of the wind stress. The surface drift velocities obtained

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#### Group 2H-Lakes

by these two approaches were found to be in close agreement. However, the estimate based on the mean wind speed was preferred because of its mean wind speed was preferred because of its simplicity. Doppler frequency shift can be corrected in either the frequency or the equivalent spatial domain. A comparison of these techniques were found to produce comparable results. Experimental results showed that the spectral energy of short waves rapidly increased in response to increasing winds and jumped up by an order of magnitude when wave breaking occurred. (Author's abstract) 1827.0714

CLIMATIC DATA FOR MIRROR LAKE, WEST THORNTON, NEW HAMPSHIRE, 1981-1982, Geological Survey, Lakewood, CO. Water Re-

sources Div. sources Div.

A. M. Sturrock, D. C. Buso, G. M. Bieber, L. G. Englebrecht, and T. C. Winter.

Available from USGS, OFSS, Box 25425, Denver, CO 80225, USGS Open File Report 84-816, 1984.

56 p, 5 tab, 1 ref.

Descriptors: \*Limnology, \*Evaporation, \*Heat budget, \*Mirror Lake, \*New Hampshire, Precipi-tation, Water balance, Water budget, Glacial ter-race, Appalacian Mountains.

Research on the hydrology of Mirror Lake, (north-central) New Hampshire includes study of evaporation. Presented here are those climatic data needed for energy-budget and mass-transfer studies, including: temperature of lake water surface, dry-bulb and wet-bulb air temperatures, with speed, precipitation and solar radiation. Data are collected at raft and land stations. (USGS)

CLIMATIC DATA FOR WILLIAMS LAKE, HUBBARD COUNTY, MINNESOTA, 1984, Geological Survey, Lakewood, CO. Water Resources Div.

sources Div.
A. M. Sturrock, D. O. Rosenberry, J. L.
Scarborough, and T. C. Winter.
Available from USGS, OFSS, Box 25425, Denver,
CO 80225. USGS Open File Report 86-64, 1986. 63 p. 6 tab. 1 ref.

Descriptors: \*Limnology, \*Evaporation, \*Heat budget, \*Climatic data, \*Williams Lake, \*Minneso-ta, Precipitation, Water budget, Hydrologic data, Lakes, Glacial terranes.

Research on the hydrology of Williams Lake, north-central Minnesota includes study of evapora-tion. Presented here are those climatic data needed for energy-budget and mass-transfer studies, in-cluding: water-surface temperature, dry-bulb air cluding: water-surface temperature, dry-buto air temperatures, wind speed, precipitation, and solar and atmospheric radiation. Data are collected at raft and land stations. (USGS) W87-09815

ISOTOPIC COMPOSITION AND ORIGIN OF LACUSTRINE BRINES IN THE ARCTIC, Quebec Univ., Montreal. Dept. des Sciences de la Terre.

P. Page, J. Michaud, M. Ouellet, and M. Dickman. Canadian Journal of Earth Sciences CJESAP, Vol. 24, No. 2, p 210-216, February 1987. 6 fig, 36 ref.

Descriptors: \*Saline lakes, \*Water chemistry, \*Meromictic lakes, \*Isotope studies, \*Water properties, \*Brines, Chemical properties, Lakes, Arctic Archipelago, Sodium chloride, Hydrogen isotopes, Hydrogen, Oxygen isotopes, Oxygen, Bottom water, Meteoric water, Diagenesis.

Meromictic lakes in the Arctic Archipelago were analyzed to determine whether the isotope content of the water molecule might confirm their oceanic origin. The 25 m bottom layer of Lake Garrow, on Little Cornwallis Island, is filled with a homogeneous sodium chloride solution with 2.6 times the chloride concentration of seawater (52 g/L). Its delta Ol8 value is around -1.0% with respect to V-SMOW, and its delta H2 is eight times the oxygen value (approximately -8.5%. In Lake Sophia on Cornwallis Island, the deep stratum (25 m thick) is less concentrated (35 g/L/Cl) and shows slightly

higher delta O18 and delta H2 values (-0.9 and -7.5% respectively). Chemocline and surficial waters result from mixing between bottom waters waters result from mixing between bottom waters and meteoric waters. The chemical and isotopic signals are interpreted as evidence of diagenesis through subpermafrost or intrapermafrost freezing of aquifers once filled with seawater, at some time during postglacial emergence. (Author's abstract) W87-09919

STUDIES OF QUATERNARY SALINE LAKES -III, MINERAL, CHEMICAL, AND ISOTOPIC EVIDENCE OF SALT SOLUTION AND CRYS-TALLIZATION PROCESSES IN OWENS LAKE,

CALIFORNIA, 1969-1971,
Geological Survey, Menlo Park, CA.
G. I. Smith, I. Friedman, and R. J. McLaughlin.
Geochimica et Cosmochimica Acta GCACAK,
Vol. 51, No. 4, p 811-827, April 1987. 6 fig, 6 tab,

Descriptors: \*Saline lakes, \*Salts, \*Lakes, \*Saline water, \*Chemical properties, \*Salinity, Salt solution, Salt crystallization, Brines, Crystallization, Owens Lake, California, Flooding, Drying, Isotope studies, Seasonal variation, Temperature effects, Mineralogy, Water temperature.

fects, Mineralogy, Water temperature.

As a consequence of the 1969-70 flooding of normally dry Owens Lake, a 2.4 meter deep lake formed and 20% of the 2 meter thick salt bed dissolved in it. Its desiccation began August 1969, and salts started crystallizing September 1970, ending August 1971. Mineralogic, brine-composition, and stable-isotope data plus field observations showed that while the evolving brine composition established the general crystallization timetable and range of primary and secondary mineral assemblages, it was the daily, monthly and seasonal temperature change that controlled the details of timing and mineralogy during this depositional process. Deuterium analyses of lake brine, interstitial brine, and hydrated saline phases helped confirm the sequence of mineral crystallizations and temperature of waters involved in the reactions. Monitoring the lake-brine chemistry and mineralogy of the accumulating salts showed: (1) An estimated 90000 tons of CO2 was released to the atmosphere or consumed by the lake's biomass An estimated section of CO2 was released to the atmosphere or consumed by the lake's biomass prior to most salt crystallization; (2) After deposition, some salts reacted in situ to form other minerals, in less than one month, and all salts except halite decomposed or recrystallized at least once in response to seasons; (3) Warming in early 1971 caused solution of all mirabilite and some of the caused solution of all imraoulte and some of the natron deposited a few months earlier, a deepening of the lake (although the lake-surface lowered), and an increase in dissolved solids; (4) Phase and solubility-index data suggest that at the close of desiccation, Na2CO3.7H2O, never reported as a mineral, could have been the next phase to crystal-liter (A). lize. (Author's abstract) W87-09929

GENE TRANSFER AMONG BACTERIA IN SOIL AND AQUATIC ENVIRONMENTS: A REVIEW, Quelph Univ. (Ontario). Dept. of Environmental

Biology. J. T. Trevors, T. Barkay, and A. W. Bourquin. Canadian Journal of Microbiology CJMIAZ, Vol. 33, No. 3, p 191-198, March 1987. 2 tab, 92 ref.

Descriptors: \*Bacteria, \*Soil bacteria, \*Aquatic bacteria, \*Gene transfer, \*Reviews, \*Literature reviews, Ecology, Ecological effects, Environmental effects, Equilibrium.

Because increasing importance is placed on recom-binant microbiological products in agriculture and binant microbiological products in agriculture and environmental management, it is necessary to develop procedures for the study of gene transfer in the environment since these transfers may result in new phenotypes that can cause changes in existing ecological equilibria. Gene transfer in the environment is affected by a large number of unpredictable and dynamic physicochemical and biological factors. At present, little is known about the ecology, physiology, and genetics of the many microbial species that inhabit soil and waters so it is impossi-

ble to test or understand all the possible genetic interactions. A balance between laboratory and in situ studies may produce helpful results, as was demonstrated by several of the studies cited in the review which summarizes the currently available literature on gene transfer in soil and aquatic environments. (Wood-PTT) W87-09931

NEARSHORE CARBONATE DEPOSITS IN LAKE TANGANYIKA, Arizona Univ., Tucson. Dept. of Geosciences. A. S. Cohen, and C. Thouin. Geology GLGYB, Vol. 15, No. 5, p 414-418, May 1987. 3 fig. 2 tab, 27 ref. NSF Grant BSR-8415289.

Descriptors: \*Sedimentology, \*Sedimentation, \*Tectonic lakes, \*Lake Tanganyika, \*Limnology, \*Carbonates, Sand, Facies, Lakes, Stratigraphy.

An exceptionally wide variety of carbonate facies, An exceptionally wide variety of carbonate facies, dominated by high-magnesian calcite, occurs along the littoral and shallow sublittoral zones (< 50 m) of Lake Tanganyika in central Africa. These facies include exposed and submerged, calcite-cemented ridges of nearshore terrigenous sand, ooid sand shoals, and lithified oolite ridges, Chara meadows of bioturbated calcareous silts, gastropod shell blankets and related coquinas, and extensive thrombolitic microbial reefs. Though texturally and compositionally similar to many modern and ancient shallow-water marine facies, these deposits record carbonate deposition and cementation in a large, tropical, deep-water lake of textonic origin. large, tropical, deep-water lake of tectonic origin. Lithofacies along Lake Tanganyika represent the broadest spectrum of carbonate deposits yet reported from any modern lake and serve as important analogues for lacustrine carbonate sequences in the stratigraphic record. (Author's abstract)

RELATIONSHIP OF AQUATIC ECOREGIONS, RIVER BASINS AND PHYSIOGRAPHIC PROVINCES TO THE ICHTHYOGEOGRAPHIC REGIONS OF OREGON, Northrop Services, Inc., Corvallis, OR. R. M. Hughes, E. Resstad, and C. E. Bond. Copeia COPAAR, No. 2, p 423-432, May 1987. 5 fig. 2 tab, 17 ref. EPA Cooperative Agreement 810501-01-0 and Contract 68-03-3124.

Descriptors: \*Fish populations, \*Oregon, \*River basins, \*Ichthyogeography, Aquatic habitats, Fish, Population dynamics, Taxonomy.

Records from 9100 collections of fishes from 1300 Records from 9100 collections of fishes from 1300 Oregon localities were subjected to cluster and detrended correspondence analyses to examine regional patterns in fish faunas. The results were compared to maps of aquatic ecoregions, river basins, and physiographic provinces. There was considerable agreement between the results of the multivariate analyses and the aquatic ecoregions and river basins. This agreement supports the use of aquatic ecoregions to help explain ichthyogeographic regions. (Author's abstract) W87-09939

NOTE ON INDIRECT DETECTION OF SEICHES IN GREAT SALT LAKE, UTAH BY NOAA AND LANDSAT SATELLITE IMAGERY, National Environmental Satellite, Data, and Information Service, Washington, DC. For primary bibliographic entry see Field 7B. W87-09996

OBSERVATIONS ON LAKE ONTARIO BASIN HYDROGEOLOGY FROM OPTICAL EN-HANCEMENTS OF LANDSAT IMAGERY, Regional Remote Sensing Facility, Nairobi (Kenya). For primary bibliographic entry see Field 7B. W87-10009

ACCURACY EVALUATION OF LANDSAT DIG-ITAL CLASSIFICATION OF VEGETATION IN THE GREAT DISMAL SWAMP, Geological Survey, Suffolk, VA

Lakes-Group 2H

For primary bibliographic entry see Field 7B. W87-10013

USING LANDSAT MSS DATA WITH SOILS INFORMATION TO IDENTIFY WETLAND HABITATS

Purdue Univ., Lafayette, IN. Dept. of Forestry and Natural Resources.
For primary bibliographic entry see Field 7B.
W87-10014

IMPROVEMENTS IN LAKE VOLUME PRE-DICTIONS USING LANDSAT DATA,
National Aeronautics and Space Administration,
Greenbelt, MD. Goddard Space Flight Center.
J. C. Gervin, and S. F. Shih.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 479-484, 3 fig, 4 tab, 3 ref.

Descriptors: \*Lake volume, \*LANDSAT, \*Data interpretation, \*Data acquisition, \*Hydrology, \*Lake Okeechobee, \*Florida, \*Satellite technology, \*Remote sensing, \*Water budget, \*Wetlands.

A cumulative error in the water balance budget for Lake Okeechobee produces a one million acre-foot discrepancy in the predicted water volume over a 4-year period. The major source of error appears to be complex shoreline marshes that comprise 20% of the lake surface. The water balance budget 20% of the lake surface. The water balance budget model presently treats these marshes as open water. Using Landsat data, the vegetation in the lake's littoral zone was classified multispectrally to provide a data base for determining water budget information. First, the acreage of a given plant species in the littoral zone was obtained with satelite data. Second, the surface area occupied by plants (which therefore could not be considered open water) was used to adjust the vegetation acreage giving an effective water surface. Based on this information, more detailed representation of evapotranspiration and total water surface (and hence total lake volume) could be provided to the water balance budget computation. (Author's abstract) stract) W87-10015

LANDSAT HYDROBIOLOGICAL CLASSIFI-CATION FOR AN INLAND FRESH WATER MARSH WITHIN EVERGLADES NATIONAL

PARK,
Everglades National Park, Homestead, FL. South
Florida Research Center. For primary bibliographic entry see Field 7C. W87-10016

COMPARISON OF REMOTE SENSING TECH-NIQUES FOR MINNESOTA WETLANDS CLASSIFICATION, Lockheed Electronics Co., Inc., Houston, TX. For primary bibliographic entry see Field 7B. W87-10017

LANDSAT INTERPRETATION OF PRAIRIE LAKES AND WETLANDS OF EASTERN SOUTH DAKOTA, South Dakota State Univ., Brookings. Remote

Sensing Inst. For primary bibliographic entry see Field 7C. W87-10018

TECHNIQUE FOR IMPROVED ASSESSMENT OF FLOW RESISTANCE CHARACTERISTICS OF NATURAL WETLANDS USING LANDSAT

DATA, National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. For primary bibliographic entry see Field 7B. W87-10019

USING LANDSAT IMAGERY TO STUDY THE OKAVANGO SWAMP, BOTSWANA, For primary bibliographic entry see Field 7B. W87-10020

COMPUTER-IMPLEMENTED REMOTE SENS-ING TECHNIQUES FOR MEASURING COAST-AL PRODUCTIVITY AND NUTRIENT TRANS-PORT SYSTEMS.

National Aeronautics and Space Administration, NSTL Station, MS. Earth Resources Lab. For primary bibliographic entry see Field 7B. W37-10021

ASSESSMENT AND CLASSIFICATION OF SE-LECTED ILLINOIS LAKES THROUGH THE APPLICATION OF SPACE TECHNOLOGY, Illinois State Environmental Protection Agency, Springfield. Div. of Water Pollution Control. For primary bibliographic entry see Field 7B. W87-10033

THERMAL PATTERNS OF LAKE MICHIGAN AND LAKE SUPERIOR FROM SATELLITE REMOTE SENSORS AND ITS USES, National Weather Service Forecast Office, Rosemont, IL.

For primary bibliographic entry see Field 7B. W87-10034

LAKE ONTARIO DYNAMICS AND WATER QUALITY OBSERVATIONS USING THEMATI-CALLY ENHANCED LANDSAT DATA, Regional (Kenya). Remote Sensing Facility, For primary bibliographic entry see Field 7B. W87-10035

APPLICATION OF DIGITAL IMAGE PROCESSING TECHNIQUES AND INFORMATION SYSTEMS TO WATER QUALITY MONITORING OF LAKE TAHOE, Jet Propulsion Lab., Pasadena, CA. For primary bibliographic entry see Field 7B. W87-10036

TROPHIC STATE DETERMINATION FOR SHALLOW COASTAL LAKES FROM LAND-

SAT IMAGERY, North Carolina State Univ. at Raleigh. Dept. of For primary bibliographic entry see Field 7B. W87-10037

EFFECTS OF ENVIRONMENTAL PH ON AM-MONIA EXCRETION, BLOOD PH, AND OXYGEN UPTAKE IN FRESH WATER CRUS-

Hartwick Coll., Oneonta, NY. Dept. of Biology. For primary bibliographic entry see Field 5C. W87-10075

IDENTIFICATION OF A METALLOTHION-EIN-LIKE, HEAVY METAL BINDING PRO-TEIN IN THE FRESHWATER BIVALVE, COR-TEIN IN THE FRESHWATER BIVALVE, COR-BICULA FLUMINEA, Virginia Polytechnic Inst. and State Univ., Blacks-burg. Dept. of Biology. For primary bibliographic entry see Field 5A. W87-10077

EFFECTS OF NUTRIENTS AND ZOOPLANK-TON SIZE ON THE STRUCTURE OF A PHY-TOPLANKTON COMMUNITY, Illinois Univ. at Urbana-Champaign. Dept. of Ecology, Ethology and Evolution.

Ecology ECOLAR, Vol. 68, No. 3, p 624-635, June 1987. 3 fig. 5 tab, 41 ref. Illinois Water Resources Center Grants S-086-ILL and S-093.

Descriptors: \*Nutrients, \*Zooplankton, \*Phytoplankton, \*Lakes, \*Limnology, Biomass, Fish, Predation, Population dynamics.

In situ enclosure experiments were conducted over two summers (1980-1981) to assess the effects of nutrient (N and P) enrichment and zooplankton size structure on the phytoplankton community of an oligo-mesotrophic lake containing planktivo-

rous fish and small zooplankton species. Exclusion of fish from the community resulted in an increase in mean individual zooplankton size, primarily because the cladocerans Ceriodaphnia and Diaphanosoma attained larger sizes. In 1980, total cladoceran biomess were also greater, when the property in th cause the cladocerans Ceriodaphina and Diaphanosoma attained larger sizes. In 1980, total cladoceran biomass was also greater in the absence of fish. In 1980, total phytoplankton density was significantly lower in the fishless enclosures (where zooplankton were larger and grazing rates presumably higher), at a given nutrient level. The proportion of phytoplankton density comprising species with gelatinous sheaths or other protective coverings was greater in the fishless enclosures, under both enriched and unenriched conditions, presumably because these species are relatively resistant to zooplankton grazing. In 1981, when lower fish densities were used (than in 1980), total phytoplankton density was lower in the fishless enclosures only toward the end of the experiment and only in unenriched enclosures. In enriched enclosures the presence of fish had no effect on total phytoplankton density made up of small, edible (to zooplankton) phytoplankton species was lower in the absence of fish. Nutrient enrichment in both unenriched and enriched treatments. In both vears, nutrient enrichment caused phytoplankton density to increase greatly, in the presence and absence of fish. Nutrient enrichment increased phytoplankton density a much greater amount than did reduction in zooplankton size. The results of these experiments demonstrate that even relatively small changes in zooplankton size (i.e., shifts in size within only small species) can result in significant alterations of the phytoplankton community. However, the increase in zooplankton size fice, shifts in aize within only small species) can result in significant alterations of the phytoplankton community. However, the increase in zooplankton buffer all effects of nutrient enrichment on total phytoplankton density. (Author's abstract) sity. (Author's abstract) W87-10081

ROLE OF PREDATION IN AGE- AND SIZE-RELATED HABITAT USE BY STREAM

FISHES, North Dakota Univ., Grand Forks. Dept. of Biol-

l. J. Schlos Ecology ECOLAR, Vol. 68, No. 3, p 651-659, June 1987. 5 fig. 4 tab, 44 ref. EPA Grant R806391 and NSF BSR 8320371.

Descriptors: \*Predation, \*Aquatic habitats, \*Fish behavior, \*Streams, Centrarchids, Food chains, Diets, Fish.

The effects of age and body size on intra- and interspecific habitat relationships for 15 species of fishes in a natural second-order warmwater stream were examined. Juveniles (age 0) of all taxa and adults (> age 0) of taxa with small maximum body size (darters and cyprinids) were at high densities predominantly in shallow riffle and raceway habitats. Adults of taxa with large maximum body size (catastomids and centrarchids) were at low densities predominantly in deep pool habitats. Based on the complementarity in depth distribution of large and small fishes, controlled experiments were conducted in a semi-natural experimental stream to the complementarity in depth distribution of large and small fishes, controlled experiments were conducted in a semi-natural experimental stream to assess (1) the effect of large centrarchid piscivores in pools on the habitat use of small fishes, (2) the influence of structural complexity of pool habitats on the interaction between centrarchid predators and their prey, and (3) the effectiveness of centrarchid predators at capturing small fishes when shallow refugia exist. In the experiments, juvenile hornyhead chub, white sucker, and smallmouth bass were allowed to select one of four physical habitats in the presence and absence of adult smallmouth bass: riffle, raceway, structurally simple pool, or structurally complex pool. Predators were restricted to pool habitats so that riffles and raceways were effective refugia. Predation by bass occurred even though effective refugia were present. However, the taxa exhibited considerable variation in susceptibility to predation; white suckers were most vulnerable and smallmouth bass least vulnerable. In the absence of bass, juveniles of all taxa preferred structurally complex or structurally simple and small mouth base that the property of the suckers were most vulnerable and smallmouth bass least vulnerable. In the absence of bass, juveniles of all taxa preferred structurally complex or structurally simple results simple the suckers were though benthering insect density. all taxa preferred structurally complex or structur-ally simple pools, even though benthic insect densi-ties were higher in riffles than pools. In the pres-ence of bass, juveniles of all taxa were largely restricted to shallow riffle or raceway refugia, with

#### Group 2H-Lakes

the extent of the shift in distribution to shallow habitats related to the vulnerability of the taxa to predation. If juvenile fishes occurred in pools with centrarchid predators, juveniles were at low densities and only in pools with high structural complexity. These results suggest that the high density and extensive overlap in habitat use of small fishes in shallow habitats of small warmwater streams is related to the increased risk of predation by centered to the increase of the content of the conte related to the increased risk of predation by cen-trarchids in pools. (Author's abstract) W87-10082

PREDATION, BREEDING ASYNCHRONY, AND THE OUTCOME OF COMPETITION AMONG TREEFROG TADPOLES, Rutgers - The State Univ., Piscataway, NJ. Dept. of Biological Sciences.

P. J. Morin

Ecology ECOLAR, Vol. 68, No. 3, p 675-683, June 1987. 4 fig, 4 tab, 29 ref. NSF Grant BSR

Descriptors: \*Predation, \*Breeding, \*Competitive use, \*Tadpoles, \*Salamanders, Ponds, Bioassay, Biomass, Population dynamics.

Densities of a predatory salamander (0,2, or 4 Notophthalmus viridescens/cu m) and a spring-breeding frog tadpole (100,200, or 400 Hyla crucifer/ cu/m), were controlled in a 3 x 3 factorial experiment replicated three times in 27 artificial experiment replicated three times of a summer-breeding frog. Hyla versicolor, were added to each artificial pond. Differences among ponds in growth and survival of H. versicolor provided a bioassay for the effects of predators and previously established competitors. Increased predator density decreased the survival and increased the mean mass at metamorphosis of H. previously established competitors. Increased predator density decreased the survival and increased the mean mass at metamorphosis of H. versicolor, regardless of H. crucifer density decreased the survival and mass at metamorphosis of H. versicolor in ponds without predators. Increased H. crucifer density decreased the survival ensity decreased the mass at metamorphosis of H. versicolor adjusted for variation among ponds in the density of survival H. versicolor over all the density of surviving H. versicolor, over all artificial ponds. Total H. versicolor biomass was negatively correlated with the biomass of H. cruci-fer metamorphs, in artificial ponds without predafer metamorphs, in artificial ponds without preda-tors. This experiment demonstrates strong compe-tition between two species of asynchronously breeding treefrogs in predator-free ponds, and thereby compromises the traditional assumption of weak interspecific competition among temporally separated species. However, predation greatly re-duces the intensity of competitive interactions among asynchronously breeding species. (Author's

GROWTH AND NUTRIENT UPTAKE POTEN-TIAL OF AZOLLA CAROLINIANA WILLD.
AND SALVINIA ROTUNDIFOLIA WILLD, AS A FUNCTION OF TEMPERATURE, Central Florida Research and Education Center,

Central Figure 20 Academy Central Figure 20 fig, 2 tab, 17 ref.

Descriptors: \*Plant growth, \*Nutrients, \*Bioaccumulation, \*Azolla, \*Salvinia, \*Temperature effects, Productivity, Cultures, Population dynamics.

Growth and nutrient uptake of Azolla caroliniana Willd. and Salvinia rotundifolia Willd. were studied under controlled conditions at constant temperatures ranging from 10 to 30 C. Maximum plant density (standing crop) occurred in the 15-20 C range, with Azolla and Salvinia attaining densities of 158 and 270 g (dry wt)/sq m, respectively. Net primary productivity was greatest within the range of 20-30 C (5.3 and 13.2 g (dry wt)/sq m/d for Azolla and Salvinia, respectively). Maximum productivity was found to occur at intermediate plant-density levels. Specific growth rate (SGR) of Azolla ranged from 0.063 to 0.142/d at 10 and 30 C, respectively, while the SGR of Salvinia was in the range 0.047-0.112/d at 10 and 25 C, respective-

ly. Nutrient removal rates in Azolla and Salvinia cultures were greatest at 20 C. Maximum rate of P uptake by Azolla was 21.4 mg/sq m/d, while maximum N and P uptake by Salvinia was 127.2 and 26.5 mg/sq m/d, respectively. (Author's abstract) W87-10084

DISTURBANCE AND RECOVERY OF AN ALGAL ASSEMBLAGE FOLLOWING FLOODING IN AN OKLAHOMA STREAM, Oklahoma Univ., Kingston. Biological Station. M. E. Power, and A. J. Stewart.

American Midland Naturalist AMNAAF, Vol. 117, No. 2, p 333-345, April 1987. 7 tab, 41 ref. DOE Contract DE-AC05-840R21400.

Descriptors: \*Algae, \*Streams, \*Flooding effects, Oklahoma, Sediments, Population dynamics.

Algae at 170 fixed sites on the bed of an Oklahoma stream were monitored 1 day before, 4 days after, and 24-26 days after a large flood. Before the flood, 81% of the sampled sites had macroscopically detectable algae. Four days after the flood, algae were macroscopically detected on only 26% of sampled sites. The proportion of sites retaining algae after the flood increased with sediment size, but did not differ between pool and riffle habitats. Rhizoclonium and Spirogyra, filamentous green algae that predominated before the flood, de-creased fourfold and 20-fold in frequency of occurcreased fourfold and 20-fold in frequency of occurrence, respectively. Tumbling experiments indicated that intrinsic differences in resistance to abrasion contributed to the significant differences in mpact of the flood on these two algae. After the 24-26 day recovery period, algae were detected on 60% of the sites. Spirogyra replaced Rhizoclonium had dominated 4 days after the flood. Spirogyra did not replace Rhizoclonium chiffle sites, and Rhizoclonium did not replace Spirogyra at any site. Replacement of Rhizoclonium by Spriogyra in pools but not in riffles restored distribution patterns of these two algae before the flood. (Author's abstract)

FOOD AND FEEDING PREFERENCES OF RAINBOW AND BROWN TROUT IN SOUTH-ERN APPALACHIAN STREAMS,

Oak Ridge National Lab., TN. Environmental Sci-

G. F. Cada, J. M. Loar, and D. K. Cox. American Midland Naturalist AMNAAF, Vol. 117, No. 2, p 374-385, April 1987. 1 fig, 5 tab, 30 ref. DOE Contract DE-AC05-840R21400.

Descriptors: \*Fish behavior, \*Trout, \*Streams, \*Food habits, Predation, Diets, Food chains, Drift.

The stomach contents of Age 1 and older rainbow (Salmo gairdneri) and brown trout (S. trutta) in five southern Appalachian soft-water streams were compared with concurrent drift samples. A wide range of food items was consumed, and no prey genus comprised an average of more than 2.5% by number of the diet of either trout species. Seasonal changes in composition of drift from June to November were generally mirrored by shifts in trout diets. The contribution of terrestrial organisms to drift and to diets was highest in late summer and diets. The contribution of terrestrial organisms to drift and to diets was highest in late summer and autumn. Averaged over all samples, terrestrial taxa comprised 36, 45 and 50% of the drift, rainbow and brown trout diets, respectively. Both trout species exhibited statistically significant feeding preferences for particular taxa (notably terrestrial organisms), but most prey were consumed in proportions similar to their abundance in the drift. Opportunistic feeding lends stability to trout populations in streams with relatively low autochthonous food production by allowing trout to capitalize lations in streams with relatively low autochthon-ous food production by allowing trout to capitalize on terrestrial input. The findings emphasize the importance of both protecting riparian vegetation (which is a source of terrestrial prey) and consider-ing aquatic habitat elements in which trout can efficiently capture surface drift when determining minimum stream flow requirements for water-di-version projects. (Author's abstract) W87-10091

PHOSPHORUS CYCLING IN ARCTIC LAKE SEDIMENT: ADSORPTION AND AUTHIGENIC MINERALS, Maryland Univ., Cambridge. Center for Environmental and Estuarine Studies.

J. C. Cornwell.

Archiv fuer Hydrobiologie AHYBA4, Vol. 109, No. 2, p 161-179, April 1987. 6 fig, 6 tab, 40 ref. NSF Grant DPP77-23475.

Descriptors: \*Limnology, \*Phosphorus, \*Arctic lakes, \*Cycling nutrients, \*Lake sediments, \*Adsorption, Minerals, Heavy metals, Iron, Sediments, Lakes, Manganese.

The distribution of P in sediment and pore water was examined in an arctic lake in which post-depositional migration of Mn and Fe results in metal oxide-enriched sediment zones. Phosphorus concentrations within the sediment correlated with Fe concentrations and the adsorption of inorganic Fe concentrations and the adsorption of inorganic P by Fe oxyhydroxides within oxic surficial sediments limits the sediment-water exchange of P. Porewater P concentrations increase in reducing sediments and a dissolution-diffusion-precipitation mechanism results in P-enriched sediment zones. The mineral vivianite is thermodynamically favored within the sediment and has been identified. The roles of authigenic mineral formation and adsorption in limiting pore water of concentrations are discussed. The rates of P cycling within the sediment are comparable to other rate terms in a whole lake P budget. (Author's abstract)

HEAVY METALS IN LAKE KINNERET (ISRAEL) III. CONCENTRATIONS OF IRON, MANGANESE, NICKEL, COBALT, MOLYBDE, NUM, ZINC, CADMIUM, LEAD AND COPPER IN INTERSTITIAL WATER AND SEDIMENT

Bayreuth Univ. (Germany, F.R.). Lehrstuhl fuer Hydrologie.

Hydrologie. T. Frevert, and C. Sollmann. Archiv fuer Hydrobiologie AHYBA4, Vol. 109, No. 2, p 181-205, April 1987. 6 fig, 6 tab, 33 ref. Deutsche Forschungsgemeinschaft Project Fr 596/

Descriptors: \*Limnology, \*Heavy metals, \*Lake Kinneret, \*Lake sediments, \*Interstitial water, \*Israel, Iron, Manganese, Nickel, Cobalt, Molyb-denum, Zinc, Cadmium, Lead, Copper.

Zn, Cd, Pb and Cu and ignition loss, Fe, Mn, Ni, Co, Mo, Zn, Cd, Pb and Cu concentrations were measured in interstitial waters and the dried sediments of Lake Kinneret, respectively. In interstitial water Zn and Pb join the pathway of R. Jordan through the lake with highest concentrations in the through the lake with highest concentrations in the northwestern part whereas Cu and Cd reach their highest concentrations in the southwestern and eastern parts of the lake which may be the effect of thermomineral spring waters. The same is due to the sediment dry weights where Fe, Mn, Ni, Co, Zn, Pb and Cu concentrations are similar to world wide averages found in less polluted lakes. Cd and significant vertical stratifications could not be detected. Hallberg's selected on water Parkers P significant vertical stratifications could not be detected. Hallberg's paleoredox parameter R = (Cu + Mo)/Zn applied to L. Kinneret, turned out to reflect the relative duration of the annual reducing and oxidizing periods as referred to by the sedimentation rate and by water regulating or climatic events during the last 40 years (RP). Thus, it is suggested that RP is a general indicator for the long-term redoxchemical cycling in monomictic lakes performing regularly oxic and anoxic (H2S-bearing) conditions at the sediment-water interface. (Author's abstract)

BIOLOGICAL SURVEILLANCE OF WATER QUALITY - 1, A COMPARISON OF MACROIN-VERTEBRATE SURVEILLANCE METHODS IN RELATION TO ASSESSMENT OF WATER QUALITY, IN A CHALK STREAM, FEEDWATER BIOLOGICAL ASSESSION.

Freshwater Biological Association, (England). River Lab. For primary bibliographic entry see Field 5A. W87-10094

#### Water In Plants-Group 21

PATTERN OF ORGANIC MATTER PRODUCTION BY NATURAL PHYTOPLANKTON POPULATION IN A EUTROPHIC LAKE 2, EXTRACELLULAR PRODUCTS,
Nagoya Univ. (Japan). Water Research Inst.
T. Hama, and N. Handa.
Archiv fuer Hydrobiologie AHYBA4, Vol. 109,
No. 2, p 227-243, April 1987. 6 fig, 2 tab, 35 ref.

Descriptors: \*Cycling nutrients, \*Limnology, \*Organic matter, \*Phytoplankton, \*Eutrophic lakes, \*Extracellular products, \*Population dynamics, Algae, Japan, Lakes, Incubation.

Diurnal change in the production of dissolved organic matter through algal excretion was examined in a eutrophic lake, Lake Suwaj, Japan. The ratios of excretion to the total (particulate and dissolved) photosynthetic production were calculated with the range from 1.4 to 2.2% when short-term incubations were used. The ratios of excretion increased from 1.5 to 7.8% in proportion to the duration of incubation in the daytime, when long-term (3-12h) incubations were used. Molecular weight distribution of the extracellular products were estimated by gel-filtration and the results showed that low molecular weight compounds whose molecular weight were less than 500 dalton, were the main component. The ratio of high mowers the main component. The ratio of high mowers the main component. whose molecular weight were less than 500 dalton, were the main component. The ratio of high molecular weight compounds accounted for small part of the total excreted compounds in the samples incubated for 3 h. However, they showed an increase as the duration of incubation increased. This result indicates that specific activity of high molecular weight compounds were lower than those of low molecular weight products. Thus, the excretion rate of high molecular weight compounds could be underestimated when the specific activity of inorganic carbon was used for conversion from radioactivity to absolute carbon value. Ion exchange resin was also applied to characterize excreted organic compounds. Polysaccharides constituted the bulk of high molecular weight compounds, whereas oligopeptides and free amino pounds, whereas oligopeptides and free amino acids, and organic acids were the main products of low molecular weight fractions. Turnover rate of dissolved organic matter through algal excretion ussoived organic matter through algal excretion was calculated from the excretion rate and the ambient concentration of each organic compound. The rates ranged from 0.0013 to 0.03/h and high rates were obtained for low molecular weight compounds. (Author's abstract)

INSECT EMERGENCE IN A STRETCH OF INSECT EMERGENCE IN A STREACH OF THE PO RIVER (ITALY), Milan Univ. (Italy). Sezione di Ecologia. B. Rossaro, and R. Cironi. Archiv fuer Hydrobiologie AHYBA4, Vol. 109, No. 2, p 245-256, April 1987. 3 fig, 6 tab, 16 ref.

Descriptors: \*Aquatic insects, \*Po River, \*Limnology, \*Emergence, \*Cattails, \*Population dynamics, Organic matter, Grain size, Flow, Velocity,

Oxygen.

Aquatic insect emergence in a Po River stretch (Italy) in three sampling sites has been examined for three years near Typha latifolia banks. The species found show a seasonal pattern of emergence that may shift in time and be of different quantity according to changes in the river, high water coinciding with a smaller number of emerging insects. Many species are temperature- and photoperiod-dependent, but the variability in peak emergence in different years suggest that the species are opportunistic. The spectrum of bottom grain-size and the percentage of organic matter content differ in the three sites. Some species, such as Harnischia angularis and Polypedilum acifer, require a moderate water speed and are more abundant in the first station. Other species, such as Tanypus punctipennis and Chironomus plumosus, tolerate low dissolved oxygen content and have maximum density in the second station. The third has characteristics intermediated for water speed and oxygen content and has a greater diversity of fauna. (Author's abstract)

COMPARATIVE STUDY OF EIGHT MATHEMATICAL MODELS FOR THE RELATION-

SHIP BETWEEN WATER TEMPERATURE AND HATCHING TIME OF EGGS OF FRESHWATER FISH,

Freshwater Biological Association, Windermere J. M. Elliott, U. H. Humpesch, and M. A. Hurley

Archiv fuer Hydrobiologie AHYBA4, Vol. 109, No. 2, p 257-277, April 1987. 7 fig. 6 tab. 26 ref.

Descriptors: \*Limnology, \*Model studies, \*Temperature effects, \*Fish eggs, \*Hatching, \*Data interpretation, Comparison studies, Fish physiology, Data sets, Fish, Reproduction, Prediction.

Three two-parameter and five three-parameter models are described and presented in both their curvilinear and linear forms. Data for hatching time at different temperatures are used to test the suitability of the eight models for six species of freshwater fish from different localities: Salmo treshwater fish from different localities: Salmo gairdneri, S. trutta, Salvelinus alpinus, S. fontinalis, Hucho hucho and Thymallus thymallus. All models, except one, provide admissible solutions for all data sets, but the goodness-of-fit varies between models. The reasons for this variation are discussed. (Author's abstract) W87-10097

FACTORS INFLUENCING THE ABUNDANCE OF TRICHOPTERA IN HARTLEY CREEK, A BROWNWATER STREAM IN NORTHEAST-ERN ALBERTA, CANADA,

Calgary Univ. (Alberta). Dept. of Biology. M. J. McElhone, R. W. Davies, and J. M. Culp. Archiv fuer Hydrobiologie AHYBA4, Vol. 109, No. 2, p 279-285, April 1987. 1 fig. 4 tab, 23 ref.

Descriptors: \*Limnology, \*Hartley Creek, \*Brownwater streams, \*Caddisflies, \*Population dynamics, Streams, Aquatic insects, Riffles, Algae.

The physical and chemical conditions in Hartley Creek, a northeastern Alberta brownwater stream, are described for a two year period and related to the composition of the Trichoptera species present. In 1976 when discharge was high, net-spinners (Hydropsyche species) were dominant in the rifles. However, in 1977 when discharge was substantially lower the Trichoptera fauna in the riffles was dominated by algal piercers (Hydroptilidae spp.). In both years the pool communities were dominated by Hydroptilidae spp. (Author's abstract) The physical and chemical conditions in Hartley stract) W87-10098

EFFECTS OF SEASONAL AND HYDROLOGI-CAL INFLUENCES ON THE MACROINVER-TEBRATES OF THE RHONE RIVER, FRANCE 1. METHODOLOGICAL ASPECTS,

Lvon-1 Univ. (France). M. Bournaud, H. Tachet, A. L. Roux, and Y. Anda.

Archiv fuer Hydrobiologie AHYBA4, Vol. 109, No. 2, p 287-304, April 1987. 7 fig, 1 tab, 21 ref.

Descriptors: \*Limnology, \*Rhone River, \*Hydrology, \*Seasonal variation, \*Taxonomy, \*Species diversity, Regression analysis, France, Flow rate.

Graphic multiple-regression analysis demonstrated the influence of 5 environmental variables (2 sea-sonal and 3 hydraulic) on the macroinvertebrates of the Rhone River at Lyon. Interactions between flow rate and season are demonstrated by fauna classification, which defines the seasonal and aperi-odic taxa through simple and multiple regression of values, which represent 62 taxa. (Author's abstract) W87-10099

SOLUBLE HUMIC SUBSTANCES FROM THE AFFLUENTS OF CHASCOMUS POND (AR-

GENTINA), Universidad Nacional de La Plata (Argentina). del Museo.

V. H. Conzonno, and A. F. Cirelli. Archiv fuer Hydrobiologie AHYBA4, Vol. 109, No. 2, p 305-314, April 1987. 7 fig, 2 tab, 18 ref.

Descriptors: \*Humic acids, \*Chascomus pond, \*Limnology, Chromatography, Ions, Affluents, Hydrogen ion concentration, Ponds, Argentina.

Studies on the influence of pH and ionic strength on the size of the soluble humic substances (HS) present in affluents of Chascomus pond (Buenos Aires, Argentina) were conscious point of buenos Aires, Argentina) were performed by gel filtration chromatography. Chemical and biological charac-teristics of the aquatic ecosystem are presented. (Author's abstract) W87-10100

#### 2I. Water In Plants

INFLUENCE OF WATER STRESS ON FLOW-ERING AND SEED PRODUCTION OF MA-CROPTILIUM ATROPURPUREUM CV. SIRA-TRO.

Queensland Univ., Brisbane (Australia). Dept. of Agriculture.

Agriculture. L. Kowithayakorn, and L. R. Humphreys. Annals of Botany ANBOA4, Vol. 59, No. 5, p 551-557, May 1987. 1 fig, 3 tab, 25 ref.

Descriptors: \*Water stress, \*Plant water use, \*Plant physiology, \*Macroptilium, \*Leaves, \*Water potentials, Flowering, Seeds, Plants, Sur-

Macroptilium atropurpureum cv. Siratro was grown in large soil beds with a constant water table below, developing a dawn leaf water potential of -0.25 MPa. Water stresses equivalent to -0.7 or -1.0 MPa were developed over 14 d, causing reduced stem and bud elongation, leaf expansion, and bud differentiation and survival. Apex size, the proportion of buds which were floral or vegetative, the early phases of floral initiation, and seed formation on advanced inflorescences were little affected during the water deficit period. Upon rewatering previously stressed plants showed inarrected during the water dencit period. Upon rewatering previously stressed plants showed increases relative to control plants in the rates of shoot appearance, leaf expansion and new node appearance. The ratio of buds becoming floral was independent of watering treatment, and the enhanced rate of floral bud production in the previous hanced rate of floral bud production in the previously-stressed treatments was due to higher rates of total bud differentiation which persisted for up to six weeks after rewatering. Survival of floral buds was reduced by previous stress, but number of flowers per inflorescence, pod setting, seed number per pod and 100-seed weight were independent of treatment. Seed production was controlled by inflorescence density. Rate of seed production was independent of treatment during water deficit and four weeks subsequently, and was then enhanced by 46 and 54 ner cent relative to the then enhanced by 46 and 54 per cent relative to the control in the -0.7 and -1.0 MPa treatments respectively. (Author's abstract) W87-09674

TWO-DIMENSIONAL MODEL FOR WATER UPTAKE BY DESERT SUCCULENTS: IMPLICATIONS OF ROOT DISTRIBUTION,

CATIONS OF ROOT DISTRIBUTION, California Univ., Los Angeles. Dept. of Biology. E. R. Hunt, and P. S. Nobel. Annals of Botany ANBOA4, Vol. 59, No. 5, p 559-569, May 1987. 10 fig. 1 tab, 26 ref. DOE Contract DE-AC03-76-SF00012.

Descriptors: \*Model studies, \*Plant water use, \*Succulents, Simulation, Roots, Prediction, Soil layers, Temperature.

Water uptake by Agave deserti and Ferocactus acanthodes was predicted using a two-dimensional simulation model in which the soil around a plant was divided into a series of lavers and concentric was divided into a series of hayers and concentrate cylindrical shells. Root lengths in 0.05 m thick soil layers were determined for both species in the field, where mean root depths were only 0.11 m for A. deserti and 0.10 m for F. acanthodes. For a year with average precipitation (159 mm), 42 per cent of the annual precipitation could be taken up by A. deserti and 25 per cent by F. acanthodes. Predicted water uptake by both species was greater from the upper soil layers (above 0.15 m) for average and dry years, but was greater from the deeper layers for a wet year. The actual root

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distribution for both species led to more water uptake than when all of the roots were in a single layer. The large number of days per year when the soil temperatures exceeded 57 C (the temperature for 50 per cent inhibition of uptake of a vital stain by root cells) may exclude roots from the 0.00-0.05 m soil layer, even though water uptake when all roots were located there was predicted to be maxi-mal. Therefore, the observed root distribution of mai. Therefore, the observed root distribution of A. deserti and F. acanthodes may be limited near the soil surface by high temperatures and at maximum depths by water availability for all but wet years. (See also W87-09676) (Author's abstract) W87-09675

ALLOMETRIC ROOT/SHOOT RELATION-SHIPS AND PREDICTED WATER UPTAKE FOR DESERT SUCCULENTS,

California Univ., Los Angeles. Dept. of Biology. E. R. Hunt, and P. S. Nobel. Annals of Botany ANBOA4, Vol. 59, No. 5, p 571-577, May 1987. 6 fig, 26 ref. DOE Contract DE-AC03-76-SF00012.

Descriptors: \*Succulents, \*Plant water use, \*Roots, \*Model studies, Prediction, Shoots, Allometry, Plants, Seedlings.

Root morphology, shoot morphology, and water uptake for Agave deserti and Ferocactus acanthuptake for Agave desert and rerocactus acanum-odes of various sizes were studied using allometric relationships (y = a(x to the b power) and previ-ously developed water uptake model. Shoot sur-face area increased with an exponent b or 0.75 for both species. Root length and the ground area explored by the roots increased with shoot surface area with b's of 0.72 for A. deserti and 0.92 for F. acanthodes. Various sized individuals had about acaminodes. Various sizes individuals and about the same ratio of root length to explored ground area, with higher values occurring for A. deserti. Predicted water uptake averaged over the ex-plored ground area was approximately constant over a 100000-fold range in shoot surface area, suggesting that shoot size confers no intraspecific competitive advantage for water uptake. For the root lengths per explored ground area observed in the field, water uptake was predicted to be 85 per cent of maximal; water uptake could be increased by the production of more rain roots. When differences in shoot volume were accounted for by allometry, small plants had relatively less shoot surface area and relatively more root length per shoot volume than did large plants, which may be important for the water relations of seedling establishment. (See also W87-09675) (Author's abstract)

COLLECTING, PREPARING, CROSSDATING AND MEASURING TREE INCREMENT AND CORES.

Geological Survey, Reston, VA. Water Resources Div.

For primary bibliographic entry see Field 2A. W87-09853

ATTENUATION OF METALAXYL ON POTATO LEAVES BY SIMULATED ACIDIC RAIN AND RESIDENCE TIME, Boyce Thompson Inst. for Plant Research, Ithaca.

For primary bibliographic entry see Field 5C. W87-09920

METHODS FOR STUDY OF RAINDROP IMPACT ON PLANT SURFACES WITH APPLI-CATION TO PREDICTING INOCULUM DIS-PERSAL BY RAIN,
Ohio State Univ., Columbus. Dept. of Plant Pa-

For primary bibliographic entry see Field 7B. W87-09921

EFFECT OF PHLOEM WATER RELATIONS ON THE GROWTH OF PHYTOPHTHORA CINNAMOMI IN EUCALYPTUS MARGINATA, Western Australia Dept. of Conservation and La Management, Como.

J. T. Tippett, D. S. Crombie, and T. C. Hill.

Phytopathology PHYTAJ, Vol. 77, No. 2, p 246-250, February 1987. 6 fig, 3 tab, 21 ref.

Descriptors: \*Fungi, \*Trees, \*Phloem water, \*Plant tissues, \*Plant water potential, Water deficit, Australia, Fungal growth, Temperature effects,

Water potentials.

The growth rate of Phytophthora cinnamomi in the secondary phloem of Eucalyptus marginata was determined, in part, by the water status of the tissue. Phloem of trees with the greatest water deficits was the least succeptible to invasion by the fungus. The effect of tissue water status on growth of P. cinnamomi was investigated by establishing 10 plots of 15 saplings each in different rainfall zones of the northern jarrah forest in Western Australia. Stem phloem of each sapling was inoculated with P. cinnamomi in early summer, and fungal growth was monitored for 3 months by means of a Plant Impedance Ratio Meter. Phloem relative water content (RWC) was determined on the same dates that fungal growth was estimated. At some plots, phloem RWCs decreased appreciably as summer progressed. When phloem RWCs were below 85%, lesion extension ceased even though summer temperatures were highly favorable for fungal growth. Mean predawn leaf water potentials (at selected plots) in late summer varied between -0.63 and -2.5 MPa. Excised phloem pieces were used to determine the relationship of RWC to phloem water potential. RWC was related linearly to water potential. RWC was related linearly to water potential over the range 75-100% RWC, corresponding to water potentials of -1.5 to 0 MPa, respectively. Fungal growth in excised stem blocks was also correlated with phloem water potential and RWC. (Author's abstract)

STOMATAL RESPONSES TO RAPIDLY IM-POSED WATER STRESS AND LIGHT/DARK TRANSITION IN NORFLURAZON-TREATED WHEAT LEAVES, Goeteborg Univ. (Sweden). Dept. of Botany. H.-O. Hoglund, and R. Klockare. Physiologia Plantarum PHPLAI, Vol. 69, No. 3, p 447-480, March 1987. 4 fig, 17 ref.

Descriptors: \*Plant physiology, \*Stomata, \*Norflurazon, \*Stomatal response, \*Water stress, \*Wheat, Leaves, Stress, Abscisic acid, Water potentials. Transpiration.

Stomatal response to rapidly imposed water stress and to light/dark transition were studied in leaves of wheat (Triticum aestivum L. cv. Starke II) treated with norflurazon (NF) which is known to inhibit abscisic acid (ABA) accumulation. The stomatal response was studied in an open air flow system. It was shown that these plants have the ability to respond to externally added ABA. When the water potential in the nutrient solution was rapidly reduced stomate in green plants responded. the water potential in the nutrient solution was rapidly reduced, stomata in green plants responded with a transient opening followed by a strongly decreased aperture. NF-treated plants responded with a similar rapid opening of stomata, but the following closure was strongly reduced. Transfer from light to darkness induced a rapid closure of stomata in green plants but the closing response was strongly delayed in NF-treated plants. These results indicate that NF affects one or more regula-tors involved in the closure of stomata under rapidtors involved in the closure of stomata under rapidly imposed water stress and in the light/dark tran-sition. The possibility that this regulator is ABA is discussed. (Author's abstract) W87-09934

ORIGIN OF GROWTH-INDUCED WATER PO-ORIGIN OF GROWTH-INDUCED WATER POTENTIAL: SALT CONCENTRATION IS LOW IN APOPLAST OF ENLARGING TISSUE, Texas A and M Univ., College Station. Dept. of Soil and Crop Sciences. H. Nonami, and J. S. Boyer. Plant Physiology PLPHAY, Vol. 83, No. 3, p 596-601, March 1987. 7 fig, 27 ref. DOE Grant DEFG05-84ER13273.

Descriptors: \*Plant water potential, \*Measuring instruments, \*Data acquisition, \*Plant growth, \*Plant physiology, Solute concentration, Water potential, Plant tissues, Apoplast, Stem tissues, Osmotic potential, Micro-osmometer. otic potential, Micro-osr

A new method was developed to measure the A new method was developed to measure the solute concentration in the apoplast of stem tissue involving pressurizing the roots of intact seedlings (Glycine max (L.) Merr. or Pisum sativum L.), collecting a small amount of exudate from the surface of the stem under saturating humidities, and determining the osmotic potential of the solution of the stem under saturating humidities. tion with a micro-osmometer capable of measuring small volumes (0.5 microliter). In the elongating small volumes (0.5 microliter). In the elongating region, the apoplast concentrations were very low (equivalent to osmotic potentials of -0.03 to -0.04 megapascal) and negligible compared to the water potential of apoplast (-0.15 to -0.30 megapascal) measured directly by isopiestic psychrometry in intact plants. Most of the apoplastic water potentials of the apoplastic water potentials. intact plants. Most of the apoplastic water poten-tial consisted of a negative pressure that could be measured with a pressure chamber (-0.15 to -0.28 megapascal). Tests showed that earlier methods involving infiltration of intercellular spaces or involving infiltration of intercellular spaces or pressurizing cut segments caused solute to be released to the apoplast and resulted in spuriously high concentrations. These results indicate that, although a small amount of solute is present in the apoplast, the major component is a tension that is part of a growth-induced gradient in water potential in the enlarging tissue. The gradient originates from the extension of the cell walls, which present tweet from seathers. from the extension of the cell waits, which pre-vents turgor from reaching its maximum and cre-ates a growth-induced water potential that causes water to move from the xylem at a rate that satisfies the rate of enlargement. The magnitude of the gradient implies that growing tissue contains a large resistance to water movement. (Author's abstract) W87-09941

INFLUENCE OF WATER RELATIONS AND TEMPERATURE ON LEAF MOVEMENTS OF RHODODENDRON SPECIES, Virginia Polytechnic Inst. and State Univ., Blacks-

Virginia Polytectanic Inst. and State Univ., Blacksburg. Dept. of Biology. E. T. Nilsen. Plant Physiology PLPHAY, Vol. 83, No. 3, p 607-612, March 1987. 9 fig., 29 ref. Virginia Polytechnic Institute College of Arts and Sciences Grant 1896210.

Descriptors: \*Leaves, \*Plant water potential, \*Temperature effects, \*Plant physiology, \*Rhodo-dendrons, Field tests, Laboratory tests, Leaf movements, Temperature, Leaf temperature, Water potential, Turgor.

Rhododendron maximum L. and R. catawbiense Rhododendron maximum L. and R. catawbiense L. are subcanopy evergreen shrubs of the eastern United States deciduous forest. Field measurements of climate factors and leaf movements of these species indicated a high correlation between leaf temperature and leaf curling; and between leaf water potential and leaf angle. Laboratory experiments were performed to isolate the influence of temperature and cellular water relations on leaf ments were performed to isolate the influence of temperature and cellular water relations on leaf movements. Significant differences were found between the patterns of temperature induction of leaf curling in the two species. Leaves of the species which curled at higher temperatures (R. catawbiense) also froze at higher leaf temperatures. However, in both cases leaf curling occurred at leaf temperatures two to three degrees above the leaf freezing point. Pressure volume curves indicated that cellular turgor loss was associated with a maximum of 45% curling while 100% or more curling occurred in field leaves which still had positive cell turgor. Moisture release curves indicated that 70% curling requires a loss of greater than 60% of symplastic water which corresponds to leaf water potentials far below those experienced in field situations. Conversely, most laboratory induced changes in leaf angle could be related to leaf cell turgor loss. (Author's abstract) W87-09942

#### 2J. Erosion and Sedimentation

ALLUVIAL STREAMBED DEGRADATION. Georgia Inst. of Tech., Atlanta. School of Civil Engineering. T. W. Sturm, and D. M. Skolds.

Available from the National Technical Information Service, Springfield, VA 22161, as PB87-179537/

#### Erosion and Sedimentation—Group 2J

AS, A05 in paper copy, A01 in microfiche. Environmental Resources Center, Georgia Institute of Technology, Atlanta. Report No. ERC 01-86, July 1986. 87 p, 37 fig. 37 ref. Contract No. 14-08-0001-G-1011. USGS Project No. G-1011-07.

Descriptors: \*Streambed degradation, \*Streamtube approach, \*Sediment transport, Alluvial River, Streambeds, Bed loads, Dams Rivers, Scour, Sediment. Model studies, Alluvial deposits.

The effect of man's activities on an alluvial river are investigated in this research. Specifically, streambed adjustments downstream of a dam constructed on a wide alluvial river are studied experimentally in a laboratory model of an existing alluvial river. The experimental results show that both scour and fill occur in the river bed downstream of several results. vial river. The experimental results show that both scour and fill occur in the river bed downstream of the dam as the result of an alluvial bar moving through the system. The bar originates from the local scour hole just downstream of the outlet structure. The channel becomes choked on one side by the bar, while scour occurs on the opposite side of the channel. A numerical model using the streamtube approach is developed to enable prediction of both scour and fill in the same river cross section. The numerical model is tested for sensitivity to the upstream boundary condition, the sediment porosity, the sediment transport relation, and the numerical time step. When compared with the experimental results, the numerical model results agree with the observed scour and fill trends, but the magnitudes are unpredicted. The streamtube approach was found to be a visible technique for investigating two-dimensional streambed adjustments, but additional refinements related to the fundamental problems of transverse velocity distribution and widening due to streambank failure are needed as these problems are illuminated by further research. (Sturm-GIT)

STATUS OF ANADROMOUS FISH HABITAT IN THE NORTH AND SOUTH FORK TOUTLE RIVER WATERSHEDS, MOUNT ST. HELENS, WASHINGTON. 1984, Washington Univ., Seattle. Fisheries Research

Inst.
R. P. Jones, and E. O. Salo.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB86-170479/
AS. Price codes: A04 in paper copy, A01 in microfiche. Washington Water Research Center, Pullman. Project Completion Report, January 1986. 53,
p, 6 fig. 7 tab, 10 ref. Contract No. 14-08-0001G940. USGS Project No. G940-07 (A-131WASH) WASH

Descriptors: \*Fish habitats, \*Sedimentation, \*Vol-canoes, \*Washington, Lateral scour pool, Plunge pool, Trench pool, Dammed pool, Backwater pool, Riffles, Rapids, Cascades, Channel morphol-ogy, Mt. St. Helens, Toutle River.

The eruption of Mount St. Helens destroyed 218 km of the 280 km (77%) of the anadromous salmonid habitat in the Toutle River drainage. In the summer of 1984, channel morphology, instream cover, riparian vegetation, and juvenile salmonid distribution were studied in impacted and unaffected tributaries. The studies reported the status of stream channel recovery and riparian zone revegetation, the condition of existing salmonid habitat and instream cover, and the distribution of juvenile salmonids. Tributaries of the North Fork Toutle and instream cover, and the distribution or juvenile salmonids. Tributaries of the North Fork Toutle River and reaches of the South Fork have created new channel or re-developed old stream beds to near pre-cruption levels. Woody debris and riparinear pre-cruption levels. Woody deems and ripar-ant timber exposed during this process contributed to rapid channel development and formation of preferred fish habitat. Tributaries with the large woody debris removed developed slower as evi-dence by channel instability, the absence of well-defined pools, and a greater incidence of riffles. defined pools, and a greater incidence of riffles. The regrowth of riparian trees which promotes channel stability, moderate water temperature, and provides large organic debris will determine the time frame of habitat recovery. The input of large organic debris resulting from riparian trees will occur in less than 50 years in tributaries throughout the lower and middle portions of the Toutle River watershed. The absence of riparian trees on

the landslide debris flow and in the upper portions of the South Fork Toutle watershed will retard the recovery of salmonid habitat in these areas. Juvenile salmonids occur in tributaries in the North and South Fork Toutle River watershed, except those North Fork tributaries draining the landslide debris-flow areas. (Salo-U of Wash) W87-09797

MATHEMATICAL MODELS OF SEDIMENT EFFECTS ON WATER RESOURCES SYSTEMS, Mississippi Univ., University. Center for Computational Hydroscience and Engineering.

S. Y. Wang.

Available from the National Technical Information
Service, Springfield, VA 22161, as PB86-164241/
AS. Price codes: A03 in paper copy, A01 in microfiche. Mississippi Water Resources Research Institute, Mississippi State, Interim Report, September 1985. 27 p, 5 fig, 85 ref. USGS Project No. G915-

Descriptors: \*Mathematical models, \*Soil erosion, \*Sedimentation. Path of pollutants. Water quality.

Sediment is not only a major water pollutant itself but also a carrier and storage agent of other pollution. This project studied its effects on water resources by the application of the most cost-effective research methodology, numerical-empirical modeling. The most recently developed computational techniques were integrated with the most reliable empirical functions so that the complex sediment transport phenomena can be simulated on digital computers. These newly developed computer models were verified by physical data taken in the field as well as the laboratories. During the verification process, the model had to be corrected and/or refined. Once the model was verified, it is applied to investigate large scale real world problems associated with sedimentation effects on water resources systems. It can be used both in nems associated with sedimentation effects on water resources systems. It can be used both in hydraulic engineering project designs and in envi-ronmental engineering impact studies, especially the long-term environmental impact prediction. (Wang-Univ. of Miss.) W87-09805

DESCRIPTION OF SEDIMENT DATA COL-LECTED BY THE U.S. GEOLOGICAL SURVEY IN SMALL WATERSHEDS IN COAL-MINING AREAS OF THE EASTERN UNITED STATES,

AREAS OF THE EASTERN UNITED STATES, 1990-84, L. D. Arihood. Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 86-309, 1986. 15 p, 1 fig, 2 tab, 3 ref.

Descriptors: \*Hydrologic data, \*Coal mining, \*Sediment data, Soil erosion, Storm runoff.

"Sediment data, Soil erosion, Storm runoff."

Hydrologic data were collected by the U.S. Geological Survey from 20 small watersheds in the surface mining areas of the eastern United States from 1980 through 1984 as part of the Survey's coal-hydrology program. Each data set includes sediment-concentration, streamflow, and precipitation data collected at 5- or 15-minute intervals. One reason for collecting the data was to test the sediment component of a watershed model. However, adequate testing requires reliable calibration data collected at several points during the rise and fall of hydrographs of several storms. Therefore, the quantity and quality of the data sets needed to be described to determine which sets could be used to test a model adequately. The data sets are described is a table that presents information about watershed characteristics, period of record, and amount of useful sediment data. Also, similar data sets collected by 10 survey project offices during other Survey programs are described in a similar table. (USGS)

MESOTIDAL ESTUARINE SEQUENCES: A PERSPECTIVE FROM THE GEORGIA BIGHT, Georgia Univ., Athens. Dept. of Geology. For primary bibliographic entry see Field 2L.

SEDIMENTARY PROCESSES, VERTICAL STRATIFICATION SEQUENCES, AND GEO-MORPHOLOGY OF THE ROARING RIVER ALLUVIAL FAN, ROCKY MOUNTAIN NATIONAL PARK, COLORADO, Colorado Univ. at Boulder. Dept. of Geological

T. C. Blair

Journal of Sedimentary Petrology JSEPAK, Vol. 57, No. 1, p 1-18, January 1987. 17 fig, 1 tab, 26 ref.

Descriptors: "Sediments, "Sediment distribution, \*Alluvial fans, "Floods, "Flooding, "Rivers, Strati-fication, Roaring River, Colorado, Dam failure, Sedimentation, Sedimentary structures, Sediment distribution, Bed load, Sediment load, Sediment grading, Sediment transport, Suspended load, Ero-sion, Flood flow.

The Roaring River alluvial fan formed on 15 July 1982, in Rocky Mountain National Park, Colorado, by a catastrophic flood that was generated by a dam failure. The fan covers an area of 0.25 sq km, has a radial length of 0.7 km, and is up to 14 m thick. Sedimentation occurred in three phases, each producing a distinct fan lobe. Initial sedimeneach producing a distinct fan lobe. Initial sedimentation was by a noncohesive sediment-gravity flow which deposited two levees on the proximal boundaries of Lobe I. The levees consist of a poorly sorted mixture of logs, sand, pebbles, cobbles, and boulders. The first two lobes were built primarily by sheetflooding, which deposited imbricated boulders in trains behind obstacles that formed as jams between boulders or logs and upright trees. Horizontally laminated granule and sedimentation took place down fan from the tormed as jams between bounders or logs and up-right trees. Horizontally laminated granule and sand sedimentation took place down-fan from the boulders due to deceleration of the expanding sheetflood. Thin-to-medium interbedded sand and sheetflood. Thin-to-medium interbedded sand and cobble-pebble gravel couplets were deposited by sheetflooding on the third lobe. Gravel was transported as bedload by supercritical flow and deposited locally where antidunes broke. Sand was transported as suspended load and deposited where flood velocity locally decreased. The flood rechancilized at the distal end of Lobe III due to constriction between the fan and the valley margin. striction betwelse the fan and the valley margin. Deposits in the upper rechannelized reaches consist of crudely bedded cobble and pebble gravel, and interstratified pebble gravel and backsethedded sand. Deposition was by supercritical flow. The flood deposit was modified during waning the flood by noncatastrophic discharge events. These events formed braided distributary channels by erosion into the top of the sheetflood deposits. Fan building took place mostly by catastrophic unconfined discharge, whereas much of the present fan surface consists of braided channels that formed by erosion into the sheetflood deposits by noncatastrophic discharge. (Author's abstract) W87-09918

APPLICATION OF LANDSAT AND COMPUTER TECHNOLOGY TO POTENTIAL WATER POLLUTION FROM SOIL EROSION,

National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. For primary bibliographic entry see Field 5B. W87-10031

BAY OF FUNDY VERIFICATION OF A SYSTEM FOR MULTIDATE LANDSAT MEAS-UREMENT OF SUSPENDED SEDIMENT, Virginia Inst. of Marine Science, Gloucester Point. For primary bibliographic entry see Field 7B. W87-10032

REMOTE SENSING OF BANK EROSION ALONG THE MISSOURI RIVER, SOUTH DAKOTA, South Dakota School of Mines and Technology, Rapid City. Dept. of Geology and Geological En-

gineering.
For primary bibliographic entry see Field 7B.
W87-10040

PHOSPHORUS CYCLING IN ARCTIC LAKE SEDIMENT: ADSORPTION AND AUTHIGENIC MINERALS,

#### Group 2J-Erosion and Sedimentation

Maryland Univ., Cambridge. Center for Environmental and Estuarine Studi For primary bibliographic entry see Field 2H. W87-10092

HEAVY METALS IN LAKE KINNERET (ISRAEL) III. CONCENTRATIONS OF IRON, MANGANESE, NICKEL, COBALT, MOLYBDE, NUM, ZINC, CADMIUM, LEAD AND COPPER IN INTERSTITIAL WATER AND SEDIMENT DRY WEIGHTS

Bayreuth Univ. (Germany, F.R.). Lehrstuhl fuer

For primary bibliographic entry see Field 2H. W87-10093

MODIFICATIONS TO THE DESIGN PROCE-DURE FOR GRIT CHAMBERS. For primary bibliographic entry see Field 8A W87-10107

#### 2K. Chemical Processes

MASS ACCOMMODATION COEFFICIENT FOR HO2 RADICALS ON AQUEOUS PARTI-

CLES, National Center for Atmospheric Research, Boulder, CO.

For primary bibliographic entry see Field 5B. W87-09699

IDENTIFICATION AND MODELING THE IMPACT OF MARINE SHALE BEDROCK ON GROUNDWATER AND STREAM SALINITY: UPPER COLORADO RIVER BASIN,

Utah Center for Water Resources Logan. C. J. Duffy, J. J. Jurinak, S. Sangani, and A.

C. J. Durry, J. J. Juffman, S. Sangam, and A. Azimi. Available from the National Technical Information Service, Springfield, VA 22161, as PB86-167632/ AS. Price codes: A06 in paper copy, A01 in micro-fiche. Hydraulics and Hydrology Series, UWRL/ H-85/OL. Program Report G-936-02, September 1985. 104 p, 37 fig, 25 tab, 70 ref. Contract No. 14-08-0001-G936. USGS Project No. G936-02.

Descriptors: \*Groundwater pollution, \*Ground-water chemistry, \*Salinity, \*Leaching, \*Colorado River basin, \*Price River basin, Marine sediments, Irrigation, Geochemistry, Diffuse coefficients, Mixing.

Recent studies have shown that groundwater is a major contributor to stream salinity in the Upper Colorado River Basin. The primary salt sources are the marine shales that underlie the soils of much of the basin. A field site in the Price River Basin, a tributary to the Green and Colorado Rivers, was selected to study the physical and chemical factors that control the interactions between groundwater and these shales. Preliminary data were available at the site as a result of a Bureau of Reclamation study conducted by CH2M Hill. On the basis of the CH2M Hill study and the additional data collected during this study ground-water flow paths, salt transport and weathering processes were identified. Results show that the groundwater evolves from a calcium-bicarbonate water to a sodium-sulfate water with depth and water to a sodium-sulfate water with depth and distance along the flow paths. Geochemical equilibrium modeling and mass balance computations were performed using the USGS models PHREEGE and BALANCE. A preliminary saturated-unsaturated two-dimensional flow model (UNSAT) was insultant and the identity of the control of th rated-unsaturated two-dimensional flow model (UNSAT) was implemented along the identified groundwater flow path. Once satisfactory flow calibration was achieved, a solute transport model was then implemented to examine the relative imwas then implemented to examine the relative importance of advective, dispersive and diffusive mixing processes along the flow profile. Preliminary management runs were made to study the effect of possible changes in land use practices. Although additional field data must be collected to verify the proposed model, it would appear to make a realistic first step towards a quantitative physically based approach to land use-salinity control issues. (Duffy-Utah St. Univ-UCWRR)

W87-09765

BIOGEOCHEMISTRY OF THREE APPALACH-IAN FOREST SITES IN STREAM ACIDIFICATION. RELATION

Pennsylvania State Univ., University Park. Inst. for Research on Land and Water Resources. For primary bibliographic entry see Field 5B. W87-09767

CORRELATION DETECTORS FOR SELECTIVE DETECTION OF POLLUTANTS IN NAT-

URAL WATERS, Georgia Univ., Athens. Dept. of Chemistry For primary bibliographic entry see Field 5A. W87-09776

HETEROGENEOUS ADSORPTION-DESORP-TION KINETIC EXPRESSIONS GOVERNING THE AVAILABILITY OF MICROCONTAMIN-ANTS IN GROUNDWATER,

Wisconsin Univ.-Madison. Dept. of Water Chemis-

For primary bibliographic entry see Field 5B.

DATA ON SNOW CHEMISTRY OF THE CAS-CADE-SIERRA NEVADA MOUNTAINS, Geological Survey, Tacoma, WA. Water Resources Div.

L. B. Laird, H. E. Taylor, and R. E. Lombard. Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 86-61, 1986. 25 p, 1 fig, 7 tab, 15 ref

Descriptors: \*Snowpack, \*Precipitation quality, \*Chemistry of precipitation, \*Snow chemistry, \*Sierra Nevada Mountains, \*Washington, \*Oregon, \*California, Snow sampling, Precipitation, Pollutants, Water pollution sources, Cascade

Snow chemistry data were measured for solutes found in snow core samples collected from the Cascade-Sierra Nevada Mountains from late February to mid-March 1983. The data are part of a ruary to mid-March 1983. The data are part of a study to assess geographic variations in atmospher-ic deposition in Washington, Oregon, and Califor-nia. The constituents and properties include pH and concentrations of hydrogen ion, calcium, mag-nesium, sodium, potassium, chloride, sulfate, ni-trate, fluoride, phosphate, ammonium, iron, alumi-num, manganese, copper, cadmium, lead, and dis-solved organic carbon. Concentrations of arsenic and bromide were below the detection limit. W87-09814

WATER-ADIT GALLERIES IN THE VOLCAN-WATER-ADIT GALLERIES IN THE VOLLANTIC MASSIF OF FAMARA (LANZAROTE, CANARY ISLAND) (LAS MINAS DE CAPTA-CION DE AGUA EN EL MACIZO VOLCANICO DE FAMARA (LANZAROTE, ISLAS CANAR-

Comisaria de Aguas del Pirineo Oriental, Barcelona (Spain). For primary bibliographic entry see Field 4B. W87-09897

ISOTOPIC COMPOSITION AND ORIGIN OF LACUSTRINE BRINES IN THE ARCTIC. Quebec Univ., Montreal. Dept. des Sciences de la Terre.

For primary bibliographic entry see Field 2H. W87-09919

STUDIES OF QUATERNARY SALINE LAKES - III. MINERAL, CHEMICAL, AND ISOTOPIC EVIDENCE OF SALT SOLUTION AND CRYS-TALLIZATION PROCESSES IN OWENS LAKE,

CALIFORNIA, 1969-1971, Geological Survey, Menlo Park, CA. For primary bibliographic entry see Field 2H. W87-09929

URANIUM AND RARE EARTH ELEMENTS IN C02-RICH WATERS FROM VALS-LES-BAINS (FRANCE).

(FRANCE), Centre de Recherches Petrographiques et Geochi-miques, Nancy (France). A Michard, C. Beaucaire, and G. Michard. Geochimica et Cosmochimica Acta GCACAK, Vol. 51, No. 4, p 901-909, April 1987. 6 fig. 3 tab, 65 ref. INSU-CNRS ATP Transfer Grant 15-40.

Descriptors: \*Chemical properties, \*Mineral springs, \*Spring water, \*Subsurface water, \*Uranium, \*Rare earth elements, \*Isotope studies, Radioistopes, Vals-les-Bains, France, Mineral water, Chemical reactions, Hydrogen ion concentration, Uranium radioiscotopes. Uranium radioisotopes

Uranium radioisotopes.

Waters from springs at Vals-les-Bains result from the mixing of a CO2-rich, highly mineralized water with dilute, shallow subsurface water. Total content of dissolved species varies from 5 mmol/1 to 100 mmol/1. For many elements, mixing of these waters is non-linear (non-conservative) and further water-rock reactions take place. The pH is controlled by CO2 outgassing; redox conditions are controlled by both the iron hydroxide-siderite buffer and the introduction of oxygen with shallow subsurface waters. Among the major elements, concentrations of Ca, Mg, Mn, and Fe are related to mixing, CO2 outgassing and carbonate precipitation. Uranium shows a complex behavior controlled by carbonate complexing, redox conditions, mixing of waters and leaching from the rocks. The 234U/238U activity ratio is near secular equilibrium. In the more dilute waters, dissolved rare earth element (REE) patterns are almost flat with a slight negative Eu anomaly. In the concentrated waters, heavy rare earth elements (Gd-Yb, HREE) are strongly enriched relative to light rare earth elements (CG-Eb). HEEV The discontine the strongly enriched relative to light rare earth elements. are strongly enriched relative to light rare earth elements (Ce-Eu, LREE). The enrichments in HREE were related to water chemistry and to complexing with carbonate species. (Author's abstract) W87-09930

PHOSPHORUS CYCLING IN ARCTIC LAKE SEDIMENT: ADSORPTION AND AUTHIGENIC MINERALS, Maryland Univ., Cambridge. Center for Environmental and Estuarine Studies.

For primary bibliographic entry see Field 2H. W87-10092

HEAVY METALS IN LAKE KINNERET (ISRAEL) III. CONCENTRATIONS OF IRON, MANGANESE, NICKEL, COBALT, MOLYBDE-NUM, ZINC, CADMIUM, LEAD AND COPPER IN INTERSTITIAL WATER AND SEDIMENT DRY WEIGHTS,

Bayreuth Univ. (Germany, F.R.). Lehrstuhl fuer For primary bibliographic entry see Field 2H. W87-10093 Hydrologie.

#### 2L. Estuaries

SALT WATER INTRUSION: STATUS AND PO-TENTIAL IN THE CONTIGUOUS UNITED STATES,

Oklahoma Univ., Norman. Environmental and Ground Water Inst.
For primary bibliographic entry see Field 5B.
W87-09625

PHYSICAL OCEANOGRAPHY OF COASTAL WATERS.

Liverpool Univ. (England). Dept. of Oceanography. K. F. Bowden. Ellis Horwood Ltd., Chichester, England. 1983.

Descriptors: \*Coastal waters, \*Oceanography, \*Physical oceanography, Waste disposal, Drilling, Mathematical studies, Thermal stratification, Salin-

With industrial activity increasing in coastal waters, the author provides a broad base of scien-

#### WATER SUPPLY AUGMENTATION AND CONSERVATION—Field 3

#### Water Yield Improvement-Group 3B

tific knowledge, which is technically excellent, in such areas of application as coastal engineering, waste disposal to the sea, drilling and mining operations, navigation and fisheries. Every chapter commences with the basic concepts of its topic, leading to further advanced developments and applications. The author's treatment is largely quantitative, at a mathematical level which is not unduly incovers for non-methoraticians. The treatment of tative, at a mathematical level which is not unduly rigorous for non-mathematicians. The treatment of tides and tidal currents is detailed yet elementary; there is an up-to-date summary of temperature and salinity stratification in coastal waters and the associated fronts. Reference to the applications of oceanographic knowledge are of essentially practical value, e.g. in the forecasting of surface waves, storm surges, and coastal pollution. Diagrams illustrate the concepts and applications. (Lantz-PTT) W87-09627

EFFECT OF PETROLEUM HYDROCARBONS EFFECT OF PETROLEUM HYDROCARBONS ON THE MICROBENTHOS OF THE WHITE SEA LITTORAL, State Oceanographic Inst., Moscow (USSR). For primary bibliographic entry see Field 5C. W37-09677

MARINE POLLUTION AND HEALTH IN SOUTH AFRICA, Cape Town Univ. (South Africa). Dept. of Zoolo-

gy.
For primary bibliographic entry see Field 5C.
W87-09679

VERTICAL DISTRIBUTION OF AN ESTUA-RINE SNAIL ALTERED BY A PARASITE, Delaware Univ., Lewes. Coll. of Marine Studies L. A. Curtis

Science SCIEAS, Vol. 235, No. 4795, p 1509-1511, March 1987. 3 fig, 17 ref.

Descriptors: \*Snails, \*Parasites, \*Estuaries, \*Tidal areas, Beaches, Behavior, Predation, Crustaceans.

Estuarine snails Ilyanassa obsoleta bearing larvae of the trematode Gynaecotyla adunca behave singularly in comparison with conspecifics lacking this parasite. Following high tides, and especially at night, infected snails were found stranded high on beaches and sandbars. Semiterrestrial crustaceans living well up on the shore serve as the next host, and the modified (induced) snail behavior is apparently a parasite adaptation facilitating cercarial transmission to these crustaceans. The altered behavior is unusual because of its apparent enhancement of host-to-host transmission by cercariae rather than predation, the process commonly nancement of nost-to-nost transmission by cercariae rather than predation, the process commonly recognized as being enhanced by parasitic modification of host behavior. (Author's abstract) W87-09680

WATER QUALITY OF THE CHARLOTTE HARBOR ESTUARINE SYSTEM, FI.ORIDA, NOVEMBER 1982 THROUGH OCTOBER 1984, Geological Survey, Tampa, FL. Water Resources Y. E. Stoker.

Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 85-563, 1986. 213 p, 45 fig, 23 tab, 10 ref.

Descriptors: \*Estuaries, \*Water quality, \*Bottom sediments, \*Nutrients, \*Pesticides, \*Organic compounds, \*Dissolved oxygen, \*Transparency, \*Florida, \*Charlotte Harbor, lons, Metals, Radiochemical analysis, Chlorophyll, Temperature, Specific conductivity, Sediment grain size, Peace River, Myakka River, Caloosahatchee River.

The U.S. Geological Survey is conducting a multi-disciplinary, 7-year study of the Charlotte Harbor estuarine system in southwest Florida. A large part of the study is devoted to the collection, analysis, or the study is devoted to the collection, analysis, and interpretation of water quality data, including physical, chemical, and biological characteristics. This report presents the water quality and bottom sediment data collected during the first 2 years of sample collection, November 1982 through October 1984. The variables measured include nutrients, major ions, trace metals, radiochemicals, pesticides

and other organic compounds, chlorophyll, tem-perature, oxygen, specific conductance, water transparency, and sediment grain size analysis. The report also outlines the methods of data collection and analysis and provides information on sai locations and frequency of sampling. (USGS) W87-09812

DETERMINATION OF THE TRANSMISSI-VITY OF COASTAL AQUIFERS BASED ON THE OBSERVATION OF SINUSOIDAL, ON-DULATORY, TRANSITORY REGIMES IN-DUCED BY TIDAL OSCILLATIONS, INITEC, General Mola, 120, Madrid, Esp For primary bibliographic entry see Field 2F. W87-09906

MESOTIDAL ESTUARINE SEQUENCES: A PERSPECTIVE FROM THE GEORGIA BIGHT, Georgia Univ., Athens. Dept. of Geology. Georgia Only, Atlanta, Dept. of Geology.

R. W. Frey, and J. D. Howard.

Journal of Sedimentary Petrology JSEPAK, Vol.

56, No. 6, p 911-924, November 1986. 14 fig, 85 ref.

Descriptors: \*Estuaries, \*Estuarine sediments, \*Sediments, \*Model studies, Sediment distribution, Mesotidal estuaries, Tidal effects, Georgia, Strati-graphic models, Salinity.

Although much has been written about estuaries and estuarine sediments, very few facies models have been proposed to date and considerable ambi-guity remains in coastal classification schemes. Current stratigraphic concepts fail to elucidate not guity remains in coastal classification schemes. Current stratigraphic concepts fail to elucidate not only the differences between certain deltaic, estuarine and lagoon-fill sequences, but also the pronounced similarities between many riverine and salt-marsh estuarine sequences. These distinctive latero-vertical successions, recent and ancient, warrant increased scrutiny and conceptual refinement. Preliminary stratigraphic models and definitions presented here - based largely on modern Georgia estuaries - should provide a broad framework for further evaluation and clarification of the above facies relationships. From that standpoint, an estuarine sequence consists of complex, intertidal to subtidal, mostly channel-form facies dominated to some extent by tidal effects, typically displaying abrupt variations in sediment texture and composition, and in physical and biogenic sedimentary structures. Subtle to pronounced salinity gradients may be discernible; nevertheless, the features most diagnostic of the overall sequence are: (1) tidally influenced channel-form deposits, and (2) characteristic bioturbate and trace fossils. (Author's abstract) (Author's abstract) W87-09917

LANDSAT CLASSIFICATION OF COASTAL WETLANDS IN TEXAS, Texas Univ. at Austin. Bureau of Economic Geol-

For primary bibliographic entry see Field 7B. W87-10012

COMPUTER-IMPLEMENTED REMOTE SENS-ING TECHNIQUES FOR MEASURING COAST-AL PRODUCTIVITY AND NUTRIENT TRANS-PORT SYSTEMS,

National Aeronautics and Space Administration, NSTL Station, MS. Earth Resources Lab. For primary bibliographic entry see Field 7B. W87-10021

MULTISPECTRAL KELP RESOURCE SUR-

Georgia Univ., Athens. Dept. of Geography. For primary bibliographic entry see Field 7B. W87-10022

REMOTE SENSING OF COASTAL POLLUT-ANTS USING MULTISPECTRAL DATA, Delaware Univ., Newark. Coll. of Marine Studies. For primary bibliographic entry see Field 7B. W87-10023

AEROSPACE REMOTE SENSING OF THE COASTAL ZONE FOR WATER QUALITY AND BIOTIC PRODUCTIVITY APPLICATIONS, National Aeronautics and Space Administration, Hampton, VA. Langley Research Center. For primary bibliographic entry see Field 7B. W87-10024

DIGITAL ANALYSIS OF LANDSAT MSS DATA AND APPLICATION FOR COASTAL MARINE ENVIRONMENT, Toba Merchant Marine Coll. (Japan). Dept. of

Oceanography.
For primary bibliographic entry see Field 7B.
W87-10025

APPLICATIONS OF LANDSAT IMAGERY TO A COASTAL INLET STABILITY STUDY,
Texas A and M Univ. at Galveston. Dept. of Maritime Systems Engineering.
For primary bibliographic entry see Field 7B.
W87-10027

COMBINED SATELLITE IMAGERY STUDY OF COASTAL CIRCULAT ONSLOW BAY, NORTH CAROLINA, For primary bibliographic entry see Field 7B. W87-10028 CIRCULATION.

USING ENHANCED LANDSAT IMAGES FOR CALIBRATING REAL TIME ESTUARINE WATER QUALITY MODELS, Louisiana State Univ., Baton Rouge. Div. of Engineering Research. For primary bibliographic entry see Field 7B. W87-10030

TROPHIC STATE DETERMINATION FOR SHALLOW COASTAL LAKES FROM LAND-SAT IMAGERY, North Carolina State Univ. at Raleigh. Dept. of

For primary bibliographic entry see Field 7B. W87-10037

#### 3. WATER SUPPLY AUGMENTATION AND CONSERVATION

#### 3B. Water Yield Improvement

TWO-DIMENSIONAL MODEL FOR WATER UPTAKE BY DESERT SUCCULENTS: IMPLI-CATIONS OF ROOT DISTRIBUTION, California Univ., Los Angeles. Dept. of Biology. For primary bibliographic entry see Field 2I. W87-09675

ALLOMETRIC ROOT/SHOOT RELATION-SHIPS AND PREDICTED WATER UPTAKE FOR DESERT SUCCULENTS, California Univ., Los Angeles. Dept. of Biology. For primary bibliographic entry see Field 21.

SCPP METEOROLOGICAL AND STATISTI-CAL SUPPORT FOR PERIOD 1 SEPTEMBER 1985 - 31 AUGUST 1986, VOLUME II (EXPERI-MENTAL DAY SUMMARIES): INTERIM PROGRESS REPORT, Electronic Techniques, Inc., Fort Collins, CO. For primary bibliographic entry see Field 2B. W87-09686

SUPERCOOLED LIQUID WATER STRUCTURE OF A SHALLOW OROGRAPHIC CLOUD SYSTEM IN SOUTHERN UTAH, Colorado State Univ., Fort Collins. Dept. of Atmospheric Science. For primary bibliographic entry see Field 2B. W87-09916

#### Field 3—WATER SUPPLY AUGMENTATION AND CONSERVATION

#### Group 3C-Use Of Water Of Impaired Quality

#### 3C. Use Of Water Of Impaired Quality

DESULFATION OF BRACKISH WATER BY ION EXCHANGE FOR CALCIUM SULFATE SCALE CONTROL, Foster-Miller, Inc., Waltham, MA.

SCALE CONTROL,
Foster-Miller, Inc., Waltham, MA.
G. Czupryna, H. Gold, R. Levy, and R. Cappello.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB87-176236/
AS. Price codes: AO7 in paper copy, AO1 in microfiche. Final Report, September 1986. 124 p, 25 fig,
49 tab, 24 ref, 4 append. USGS Contract No. 1408-0001-01075.

Descriptors: \*Brackish water, \*Desulfation, \*Scale formation, \*Ion exchange, \*Water utilization, \*Softening, \*Lime-sods softening, \*Makeup softening, \*Cooling, Scaling, Water treatment, Water quality, Madison Aquifer, Wyoming, Powder River, Dakota Aquifer, New Mexico.

The problem of calcium sulfate scale formation on heat transfer surfaces has been the major problem in limiting the use of brackish water as an alternative water source for evaporative cooling. The overall objective of this program was to determine if sulfate control, as opposed to calcium control, is a feasible treatment method. In simulated cooling tower loop, it was found that at high calcium concentrations (5,000 mg/L), the sulfate concentration below which calcium sulfate scale does not form lies in the range of 1,000-1,250 mg/L. A laboratory scale and pilot plant test program showed that desulfation with Amberlite IRA-47 is an effective method of treating brackish waters. Three brackish waters were selected and simulated in the laboratory: Powder River, near Arvada, Wyoming; Madison Aquifer, Northeastern Wyoming; and Dakota Aquifer, Northeastern New Mexico. The pilot scale study showed that anion exchange almost completely removed the scalein limiting the use of brackish water as an alterna exchange almost completely removed the scale-forming sulfate ions. In addition, the feasibility of using calcium chloride as a regenerant was demonstrated. The waste regenerant solution could also be recycled to increase the regeneration efficiency. A cost analysis showed that the more traditional makeup and sidestream softening treatments are more cost effective than ion exchange desulfation. It would appear that calcium control is the pre-ferred method of treating brackish waters. (USGS)

ABILITY OF LETTUCE, RYE GRASS AND BARLEY TO REDUCE THE NUTRIENT SALT CONTENT OF WASTEWATER FROM FISH

Danmarks Ingenioerakademi, Lyngby. For primary bibliographic entry see Field 5D. W87-10056

#### 3F. Conservation In Agriculture

STRATEGIES FOR CONVERSION OF HIGHLY ERODING CROPLAND IN WEST TENNESSEE,
Tennessee Univ., Knoxville. Dept. of Agricultural Economics and Rural Sociology.
For primary bibliographic entry see Field 6C.
W87-09748

REDUCTION OF NITRATE LEACHING LOSSES BY COMPUTERIZED NITROGEN AND IRRIGATION WATER SCHEDULING

FOR CORN,
Michigan State Univ., East Lansing. Dept. of Crop and Soil Sciences.
For primary bibliographic entry see Field 5G. W87-09761

MODELING IRRIGATION IN THE COLUM-

BIA, Washington State Univ., Pullman. Coll. of Agriwashington State Univ., Fullman. Coll. of Agri-culture and Home Economics. J. E. Houston, and N. K. Whittlesey. Available from the National Technical Information Service, Springfield, VA 22161, as PB86-151701/

AS. Price codes: A07 in paper copy, A01 in microfiche. Washington Water Resources Research Center, Pullman. Project Completion Report 65, May 1985. 121 p, 6 fig. 27 tab, 60 ref. Contract No. 14.08-0001-G940. USGS Project No. G940-02 (A-00201-G940). 126-WASH.).

Descriptors: \*Irrigation, \*Washington basin irriga-tion, \*Water allocation, Computer models, Eco-nomic evaluation, Regional development.

Irrigated agriculture and electricity supply are in-ricately bound in the Pacific Northwest by mutual dependence on Columbia River Basin water. Water conservation opportunities exist in present irrigation which could supplement regional firm hydroelectricity, while decreasing firm irrigation electricity demand. A two-level mathematical pro-gramming model is developed to evaluate irrigator production and regional price responses to water and electricity policies. Producer decision criteria in stage one are modeled to choose cropping mixes and irrigation rates at expected commodity prices. Resource constraints are consistent with regional water policy. Stage one production and resource Irrigated agriculture and electricity supply are in-Resource constraints are consistent with regional water policy. Stage one production and resource solutions are employed in a regional allocation and price equilibrium-seeking program, and a decomposition-type linkage reiterates production area responses to regional equilibrium prices. Baseline resources, production, and crop prices are estimated for 1982. Water pricing policies which reflect the opportunity value of Columbia River water for hydrogeneration indicate increasing materials. hydrogeneration indicate increasing net social ben nyarogeneration indicate increasing net social benefits, net farm returns, and hydropower potential accruing from irrigation water conservation. Upriver areas would generally reduce water consumption most. Proportionately rationing Columbia River water creates less hydropotential per unit of water conservation than do pricing policies. Locational value of water is ignored in such a policy, distorting efficiency and distribution impacts of water conservation. Markets for rights or ontions on conserved irrigation water held received. on water conservation. Markets for rights or options on conserved irrigation water hold promise for increasing regional public welfare and irrigator incomes. (Whittlesey-WSU) W87-09793

IRRIGATED AGRICULTURAL DECISION STRATEGIES FOR VARIABLE WEATHER

New Mexico State Univ., Las Cruces. Dept. of Agricultural Economics and Agricultural Business. R. R. Lansford, T. S. Sammis, J. T. McGuckin, R.

R. R. Lansford, T. S. Sammis, J. T. McGuckin, R. A. Deitner, and J. A. Libbin. Available from the National Technical Information Service, Springfield, VA 22161, as PB86-157062/AS. Price codes: A05 in paper copy, A01 in microfiche. New Mexico Water Resources Research Institute, Las Cruces. Final Completion Report, June 1983, 38 p. 22 fig. 11 tab, 24 ref, 3 append. OWRT Project No. B067; B069(2).

Descriptors: \*Water conservation, \*Irrigation, \*New Mexico, Model studies, Ogallala Aquifer, Crop yield, Water use, Corn, Wheat, Sorghum, Economic aspects, Computer programs, Dynamic programming, Sprinkler irrigation, Flood irrigation, Water costs, Agriculture, Elasticity of

comprehensive irrigated agricultural decision A comprehensive irrigated agricultural decision making model has been developed for variable weather conditions in the Southern High Plains, which overlies the Ogallala Aquifer. The analysis includes a probabilistic precipitation prediction model, water/crop yield production functions, and an economic decision strategy model. The model is needed agreement with most physically measured. an economic decision strategy model. The model is in good agreement with most physically measured parameters. Consisting of a two-dimensional matrix with 1100 rows and a number of columns corresponding to the days in the season, the program can be loaded into a microcomputer for use with a soil moisture model. Compared with physically based irrigation models, this model increases net returns per acre from \$7 to \$25 for corn with flood trigation and a crop price of \$3.57 per bushel. For sprinkler systems, it increases corn net returns from \$2 to \$106 per acre. For wheat at \$4.68/, bushel, it increases net returns from \$1 to \$15 for from 32 to 3100 per acre. For wheat at 34.00, bushel, it increases net returns from \$1 to \$15 for flood irrigation and \$20 to \$38 for sprinkler irrigation. The model's flexibility enables the farmer to calculate maximum profits under a wide variety of

economic and physical conditions. Results also indicate that water demand is inelastic for corn but elastic for wheat and sorghum, confirming their dryland capabilities. Elasticity of demand indicates the potential water savings and economic viability of crops as water prices increase. For wheat and sorghum, substantial water savings and reduced sorghum, substantial water savings and reduced yields occur as water costs increase from modest levels. With corn, increased water costs decrease yields occur as water costs increase from modest levels. With corn, increased water costs decrease net returns, possibly taking this crop out of pro-duction. (Cassar-PTT) W87-09800

IRRIGATION USING SURFACE WATER -- AN ALTERNATIVE TO GROUND WATER OVER-

Mississippi State Univ., Mississippi State. Dept. of Mechanical and Nuclear Engineering.
R. E. Forbes.

R. E. Forbes.

Available from the National Technical Information Service, Springfield, VA 22161, as PB86-164233/
AS. Price codes: A03 in paper copy, A01 in microfiche. Mississippi Water Resources Research Institute, Mississippi State. Technical Completion Report, September 1985. 24 p, 7 tab, 5 fig, 13 ref. USGS Project No. G915-04.

Descriptors: \*Irrigation practices, \*Mississippi, \*Alternative water use, \*Mississippi River, Water reuse, Water management, Surface-groundwater relations, Alluvial aquifer.

The emphasis of this research was to perform an analysis of the options to be considered when using surface waters as an alternate to groundwater for irrigation purposes. The purpose of the project was to identify problem areas hindering widespread use to surface water, evaluate equipment suitable to use surface waters, provide an economic analysis comparing costs involved, and make recommendations concerning the use of surface water in place of well water. A thorough economic analysis was performed for three alternate general configurations of center pivot irrigation systems; two of which use surface water: 1. Center pivot with well which use surface water: 1. Center pivot with well at center, 2. Center pivot with center pump fed from surface water (drainage ditch), 3. Center riom surface water dramage ditch), 5. Center pivot with surface water piped some distance from center. The principal findings are that surface water may be delivered more cheaply than well water for several of the configurations studied. Reduced pump work more than offsets additional costs for other features of the surface water systems. This factor will take on increased importance as well water must be pumped from aquifers with dropping water levels. These data may be used by prospective irrigators to select a system (using surface water) which will deliver water at a lower cost than a well supplied system. (Forbes-MSU) W87-09804

AGRICULTURE'S NEEDS RELATED TO SAT-ELLITE HYDROLOGY, Agricultural Research Service, Beltsville, MD. Plant Physiology Inst. For primary bibliographic entry see Field 7B. W87-09958

APPLICATION OF REMOTE SENSING FOR CALIFORNIA IRRIGATED LANDS ASSESS-MENT, California Univ., Santa Barbara. Santa Barbara

Remote Sensing Unit. For primary bibliographic entry see Field 7B. W87-10038

MULTISTAGE MAPPING APPROACH FOR AN IRRIGATED CROPLANDS INVENTORY, California Univ., Santa Barbara. Santa Barbara Remote Sensing Unit. For primary bibliographic entry see Field 7B. W87-10039

SELECTED IRRIGATION ACREAGE ESTI-MATES IN NORTHERN FLORIDA FROM LANDSAT DATA, Suwanne River Water Management District, White Springs, FL.

#### WATER QUANTITY MANAGEMENT AND CONTROL—Field 4

#### Groundwater Management—Group 4B

nary bibliographic entry see Field 7B. For primar W87-10041

MAPPING IRRIGATED LANDS IN WESTERN KANSAS FROM LANDSAT, Kansas Applied Remote Sensing Program, Law-

For primary bibliographic entry see Field 7B. W87-10042

MAPPING IRRIGATED CROPLAND ON THE HIGH PLAINS USING LANDSAT, Geological Survey, Reston, VA.
For primary bibliographic entry see Field 7B.
W87-10043

#### 4. WATER QUANTITY MANAGEMENT AND CONTROL

#### 4A. Control Of Water On The Surface

INSTANTANEOUS UNIT HYDROGRAPHS: A GEOMORPHOLOGIC APPROACH, Georgia Inst. of Tech., Atlanta. School of Civil

Engineering.

A. P. Georgakakos, and J. C. Kabouris.

Available from the National Technical Information
Service, Springfield, VA 22161, as PB87-179552/

AS. Price codes: A05 in paper copy, A01 in microfiche. Environmental Resources Center, Georgia
Institute of Technology, Atlanta. Report No. ERC

03-86, July 1986. 95 p, 7 tab, 17 fig, 16 ref. Contract No. 14-08-0001-G1011. USGS Project No. G1011.03

Descriptors: \*Unit hydrographs, \*Markov Process, \*Streamflow forecasting, Infiltration, Surface runoff, Watershed management, Georgia, Little River watershed, Rainfall intensity, Model studies.

A physically-based methodology for streamflow forecasting is researched and implemented. Water-shed response is modelled as Continuous-Time Markov process whose states include both surface Markov process whose states include both surface and subsurface runoff components. Based on probabilistic arguments, time-varying Instantaneous Unit Hydrographs are derived and convoluted with antecedent rainfall intensities to generate streamflow discharges. The method is applied to the Little River Watershed in South Georgia with encouraging results. Such models are useful in quantifying the response of ungaged watersheds and predicting streamflows in real times. In turn, such studies are instrumental in the design and operation of reservoirs. (Georgakakos-GIT) W87-09777

DEVELOPMENT OF CONFIDENCE INTER-VALS AND MONTHLY DESIGN VALUES FOR LOW STREAMFLOWS,

Georgia Univ., Athens. Dept. of Statistics and Computer Science.

For primary bibliographic entry see Field 2E. W87-09779

MODEL FOR ASSESSING THE VISUAL RESOURCES OF RIVER BASINS AS AN AID TO MAKING LANDUSE PLANNING DECISIONS, Kentucky Water Resources Research Inst., Lexington.

For primary bibliographic entry see Field 6B. W87-09789

COMPARISON OF UNREGULATED AND REGULATED STREAMFLOW FOR THE YAKIMA RIVER AT UNION GAP AND NEAR

PARKER, Geological Survey, Tacoma, WA. Water Re-For primary bibliographic entry see Field 2E. W87-09811 sources Div

WATER IN MINING,

State Irrigation Commission, Lucknow (India) For primary bibliographic entry see Field 2E. sion, Lucknow (India).

#### 4B. Groundwater Management

HANGINGWALL DEWATERING AT MUFU-LIRA DIVISION OF ROAN CONSOLIDATED MINES LIMITED, ZAMBIA,

Roan Consolidated Mines Ltd., Mufulira (Zambia). For primary bibliographic entry see Field 2F. W87-09602 Mufulira Div

OPEN PIT MINE SLOPES DRAINAGE THROUGH HORIZONTAL BOREHOLES, Geotecnica S.A., Sao Paulo (Brazil).

P. C. Abrao.

In: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol-umes I, 1984. SIAMOS 78. p 573-583, 5 fig, 9 ref.

Descriptors: \*Mine drainage, \*Drainage engineering, \*Mining engineering, \*Boreholes, Groundwater level, \*Slope stability, Geohydrology, Groundwater movement, Water table, Case studies, Seepage, Drains, Piezometers, Drainage programs.

The use of horizontal boreholes for lowering the groundwater table in open pit mine slopes im-proves slope stability and provides important data on groundwater hydrology. The importance of water in controlling the stability of excavated rock and soil slopes is outlined and the many ways water can cause a mass to slide are described. Drainage programs adopted in the Caue Mine of Brazil are described. The drains have been drilled prazu are described. The drains have been drilled with a diamond drill rig, with double tube core barrel, with the maximum core recovery. Water flow recording by piezometers during the drilling operation is of major importance in effective mine slope drainage. (See also W87-09568) (Geiger-PTT) W87-09603

PRECAUTION MEASURES AGAINST SUDDEN INRUSHES OF WATER AND MUD IN COLLIERIES OF SFR YUGOSLAVIA, Ljubljana Univ. (Yugoslavia). Faculty of Natural Sciences and Technology.

IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol-umes I, 1984. SIAMOS 78. p 585-601, 6 fig, 5 ref.

Descriptors: \*Drainage engineering, \*Coal mining, \*Groundwater movement, \*Safety, \*Mining engineering, \*Mud, Mine drainage, Groundwater manit, Coal mines, Geohydrology

In Yugoslavia, coal seams of rather low heating In Yugoslavia, coal seams of rather low heating value and great thickness are mined. Up to this time numerous inrushes of mud into the faces have occurred causing great damages and also casual-ties. In order to gain a better understanding of this problem, first, the geological and hydrological coniditions of coal deposits in SFR Yugoslavia are given followed by the descriptions of the applied mining method, the caving process and the method of formation of mud accumulations, as well as the of formation of mud accumulations, as well as the mechanism of its inrush into the faces. On the basis of the analysis of casual factors, specific criteria were defined and precaution measures against sudden inrushes of mud were established. In areas amenable to mud inrush into the faces, the coal seam should be fully mined out on each level without leaving coal pillars. In mining of the lower level, mining should be carried out in a manner that the coal is simultaneously won from the hanging-wall over a front approximately 20 m long, and, as a rule, this front must be gradually moved from the floor towards the hanging-wall. The coal may be mined only to the height of the exploited level. Drainage boreholes should also be drilled as an added precaution. (See also W87-09568) (Geiger-PTT) of formation of mud accumulations, as well as the

CAVING OF A COAL SEAM UNDER KAMP-TEE AQUIFERS OF INDIA, Central Mining Research Station, Dhanbad (India). For primary bibliographic entry see Field 2F. W87-09608

GROUNDWATER PROTECTION.

GROUNDWATER PROJECTION.
Conservation Foundation, Washington, DC.
Groundwater: Saving the Unseen Resource, The
Final Report of the National Groundwater Policy
Forum; and A Guide to Groundwater Pollution:
Problems, Causes, and Government Responses.
The Conservation Foundation, Washington, DC. 1987, 240 p.

Descriptors: \*Groundwater protection, \*Groundwater potential, \*Groundwater availability, \*Groundwater management, Groundwater pollution, Legal aspects, Water quality control, Groundwater quality, Water pollution control.

This book is the product of a joint effort by The Conservation Foundation and the National Groundwater Policy Forum. The book contains the Forum's final recommendations. The Forum the Forum's inna recommendations. In e Forum calls for an aggressive national policy to assure that future generations have adequate supplies of uncontaminated groundwater. The Forum urges 'a new environmental partnership' among all levels of government, business, and public interest groups. Its recommendations include a comprehensive 10point groundwater protection program for state governments to adopt. The book also contains a governments to adopt. The book also contains a summary of public comments on the Forum's proposals, presented in writing and at three public hearings, and an extensive analysis of the groundwater pollution problem prepared independently by The Conservation Foundation staff. (Lantzby The Co PTT) W87-09621

GROUNDWATER MANAGEMENT: THE USE OF NUMERICAL MODELS, Butler Univ., Indianapolis, IN. Holcomb Research

P. Heijde, Y. Bachmat, J. Bredehoeft, B. Andrews,

and D. Holtz.

Water Resources Monograph 5, Second Edition.

American Geophysical Union, Washington, DC.
1985. 180 p.

Descriptors: \*Groundwater movement, \*Model studies, \*Groundwater management, \*Mathematical models, Management planning, Mathematical studies, Groundwater potential, Water resources development.

Numerical modeling of groundwater is a relatively new field which was not extensively pursued until the mid-1960's. Since that time, significant progress the mid-1960's. Since that time, significant progress has been made in the development and application of numerical models for groundwater related resource management. Management is here defined to include planning, implementation, and adaptive control of policies and programs related to the exploration, inventory, development, and operation of water resources containing groundwater. In spite of this progress, gaps still exist between the need for and the existence and actual use of groundwater models in management. The closing of these gaps can serve to improve the management of groundwater resources. This book contains a detailed examination of the intrinsic strengths and deficiencies of existing groundwater models, as well as consideration of a variety of other factors or circumstances which are not directly related to the models but which affect model rectly related to the models but which affect model use. Those models but which arrect models use. Those models which management needs but does not have are identified and the reasons why management does not use certain of the available models are examined. Two major aspects are discussed: (1) the needs for numerical models to adcussed: (1) the needs for numerical models to address significant groundwater problems and related management decisions; and (2) what the existing groundwater models are, and the extent to which those models meet these needs. In discussing these points, recommendations and priorities concerning measures to enhance the use and utility of models in groundwater related water resources manage-ment are presented. In this way the foundation has been laid for a unified effort and, hopefully, to aid

#### Field 4—WATER QUANTITY MANAGEMENT AND CONTROL

#### Group 4B-Groundwater Management

those who fund the development of groundwater models, as well as researchers, practitioners, and users. (Lantz-PTT)

ARTIFICIAL RECHARGE OF GROUND WATER: STATUS AND POTENTIAL IN THE CONTIGUOUS UNITED STATES,

Oklahoma Univ., Norman. Environmental and Ground Water Inst.

M. P. O'Hare, D. M. Fairchild, P. A. Hajali, and

L. W. Canter. Lewis Publishers. Inc., Chelsea, MI. 1986. 419 p.

Descriptors: \*Groundwater recharge, \*Artificial recharge, \*Groundwater management, Industrial infiltration, Aquifers, Site selection, Recharge, Recharge wells, Geohydrology.

Artificial recharge involves the transport of water via engineered systems from the surface of the earth to underground water-bearing strata, where it may be stored for future use. Direct artificial it may be stored for future use. Direct artificial recharge systems include spreading basins, re-charge pits and shafts, and recharge wells. Basins are typically used in areas with shallow unconfined aquifers; wells are used in areas with deep confined aquifers. Artificial recharge can also be accom-plished via indirect means, such as enhanced streambed infiltration and the use of conjunctive wells. As more demands are placed on groundwater resources in the contiguous United States, artificial recharge may represent an attractive option for replenishing diminishing groundwater re-sources. Technical requisites for successful artifi-cial recharge projects include favorable hydrogeocial recharge projects include favorable hydrogeo-logical conditions, and the availability of a suffi-cient quantity of source water of adequate quality. This book provides a summary of the status and potential for artificial recharge in the contiguous United States. While the focus is on artificial re-charge for enhancing groundwater availability for agricultural uses, the book is not limited to this single purpose. The book is organized into five chapters and three appendices. Key chapters are included on technical descriptions of both direct and indirect artificial recharge methods. site selecand indirect artificial recharge methods, site selec-tion and evaluation criteria for artificial recharge tion and evaluation criteria for artificial recharge projects, case studies of projects and methodologies for determining the potential of geographical areas for artificial recharge. The key appendix contains an annotated bibliography of 345 pertinent references identified from computer-based searches of the literature. (Lantz-PTT) W87-09626

GROUNDWATER RESOURCE ASSESSMENT AND MANAGEMENT RECOMMENDATIONS FOR OUTAGAMIE COUNTY, WISCONSIN, Fox Valley Water Quality Planning Agency, Men-Fox Valley asha, WI. C. Roesler.

February 1986. 178 p, 41 fig, 20 tab, 42 ref.

Descriptors: \*Groundwater management, \*Water quality control, \*Water pollution control, \*Outagamie County, \*Wisconsin, Groundwater pollution, Groundwater quality, Management planning, Resources management, Water pollution sources, Standards, Water quality standards, Groundwater.

In response to growing groundwater quality concerns and information needs, the Fox Valley Water Quality Planning Agency (FVWQPA) has taken an active role in the development of groundwater management planning information for the Fox Valley area. In 1981, the FVWQPA published a report which explained the general geology, geohydrology, and groundwater contamination potential of the Fox Valley region. Following this study, a series of reports taking a closer look at the groundwater resources of the Fox Valley on a county-by-county basis was initiated. The present is the third in this county groundwater series. The report is intended to serve a number of purposes: report is intended to serve a number of purposes:
(1) to provide a readily available reference for a
wide variety of groundwater information for the wide variety of groundwater information for the county; (2) to increase public awareness and under-standing of groundwater quality concerns; (3) to provide a basis for evaluating groundwater protec-tion needs for the county; and (4) to recommend

groundwater management actions for the county. Available groundwater information for Outagamie County has been compiled, developed, and summarized. Basic features of the groundwater resources are described and known incidents of contamination are identified. Various potential sources of groundwater contamination are discussed and inventoried. Areas in the county most susceptible to contamination from these sources are delineated. Present state and local involvement in groundwater protection and management is described, and additional options available to local government are identified. A list of groundwater management recommendations is prese W87-09690 nted. (Lantz-PTT

DESIGN OF A STATEWIDE GROUND WATER

MONITORING NETWORK,
Tennessee Technological Univ., Cookeville.
Center for the Management, Utilization and Protection of Water Resources.
For primary bibliographic entry see Field 7A.
W87-09747

IRRIGATION USING SURFACE WATER - AN ALTERNATIVE TO GROUND WATER OVER-

Mississippi State Univ., Mississippi State. Dept. of Mechanical and Nuclear Engineering. For primary bibliographic entry see Field 3F. W87-09804

'METRO' IN LYON, FRANCE. CONSTRUC-TION BELOW THE WATER TABLE (METRO DE LYON, CONSTRUCTION SOUS LE NIVEAU DE LA NAPPE PHREATIQUE), Societe d'Economie Mixte du Metropolitain de

l'Agglomeration Lyonaise (France). C. Bouyat, G. Picod, and R. Fages.

In: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volume II, 1984. SIAMOS 78. p 719-740, 7 fig.

Descriptors: \*Drainage, \*Drainage engineering, \*Hydraulics, \*Hydraulic models, \*Groundwater, \*Groundwater level, \*Underground structures, Aquifers, Rhone River, Lyon, Rivers, Hydrology, Surface-groundwater relations, Mathematical models, Model studies, France, Pumping.

The construction of the first line of Lyon's Under-The construction of the first line of Lyon's Under-ground Railway, in which structures enter the aquifer of the Rhone's alluvions, required a com-plete study of the hydrologic relations between the river and groundwater table. The mathematical models used estimated the effects of different river risings on the water table in the studied areas, the influence of the underground structures on the flood of the groundwater, and the consequences on the water table of stopping important pumping. The different calculations permitted the definition of the water levels required for each phase of the realization and the future exploitation of the works. (See also W87-09568) (Author's abstract) W87-09870 risings on the water table in the studied areas, the

DRAINAGE OF A MINE TO A CONSTANT LEVEL (DRENAJE DE UNA MINA HASTA NIVEL CONSTANTE), Granada Univ. (Spain). Dept. de Quimica Inorgan-

ica. R. Fernandez-Rubio, and A. Yague Ballester. IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volume II, 1984. SIAMOS 78. p 741-749, 1 fig. 2

Descriptors: \*Groundwater movement, \*Mine drainage, \*Groundwater, \*Drainage, \*Computer programs, \*Data interpretation, \*Groundwater level, \*Data processing, Computers, Fortran, Drainage engineering, Piezometric head, Water table, Water table decline, Piezometers, Water

During mine working it is ordinarily necessary to drain to a constant piezometric level. Flow is therefore variable. Thus, conventional methods of pumping test interpretation are not applicable to

observed water table lowering. On the basis of constant head depression, a method of computation and interpretation was developed which takes into consideration the observations in different piezometers. The presented FORTRAN computer program facilitates the data treatment. (See also W87-09588) (Author's abstract) W87-09871

SYSTEMS APPROACH FOR MINE WATER

Mining Development Central Inst., Budapest (Hungary).

Z. Kesseru, I. Bogardi, and F. Szidarovszky.

IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volume II, 1984. SIAMOS 78. p 789-804, 3 fig, 3 tab. 13 ref.

Descriptors: \*Drainage engineering, \*Mine drainage. \*Groundwater, \*Model studies, \*System analysis, Mining engineering, Groundwater management, Mathematical studies, Mathematical equations, Stochastic hydrology, Hungary, Safety, Haz-

Design and operation of mine water control war-rants the use of systems analysis. The objectives of the system are defined and include economic, life the system are defined and include economic, me protection and environmental aspects. A systems model of economic mine water control is presented. Elements of the systems model are formulated: input, state variable, output, state transition func-tion, output function. Due to the stochastic natural environment, the systems model of mine water control also has stochastic elements. The model refers to Hungarian mining conditions, but the principles are valid for any kind of mining under water hazard. (See also W87-09568) (Author's ab-W87\_00874

REDUCING WATER LEAKAGE INTO UNDER-GROUND COAL MINES BY AQUIFER DEWA-TERING

Argonne National Lab., IL. Energy and Environtal Systems Div.

I.P. Schubert

In: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volume II, 1984. SIAMOS 78. p 911-931, 6 fig, 2

Descriptors: \*Mine drainage, \*Drainage engineering, \*Groundwater movement, \*Coal mines, \*Seepage, \*Aquifers, \*Aquifer dewatering, \*Model studies, \*Data interpretation, Coal mining, Stratigraphy, Geohydrology, Pennsylvania, Computer models, Finite difference method, Mathematical studies, Mathematical equations, Simulation, Sandstone, Leakage.

Based on stratigraphic, structural, hydrogeologic, and mining data collected during a study in central Pennsylvania, a two-dimensional, finite-difference computer model was used to simulate groundwater flow in a sandstone unit (0.3 to 11 meters thick) overlying an underground mine, and to evaluate her responses of the flow system and leakage rate into the mine when hypothetical dewatering wells are introduced into the system. Simulation of well dewatering, using 25 wells, showed that negligible reduction in leakage would occur if sandstone permeability was less that 0.30 meters/day. When sandstone permeability equalled 3.0 meters/day, 25 wells reduced leakage by 2.4 percent. (See also W87-09568) (Author's abstract) W87-09881

DRAINAGE AND STABILITY PROBLEMS OF TALUSES IN AN OPEN PIT EXCAVATION IN MARQUESADO (PROBLEMES D'EXHAURE ET STABILITE DES PENTES DANS LA MINE A CIEL OUVERT DU MARQUESADO),

Ecole Nationale Superieure des Mines de Paris (France).

For primary bibliographic entry see Field 2F. W87-09882

#### WATER QUANTITY MANAGEMENT AND CONTROL-Field 4

#### Groundwater Management—Group 4B

APPLICATION OF A SIMULATION MODEL FOR A LARGE-SCALE KARSTIC WATER AQ-UIFER,

ing Development Central Inst., Budapest (Hungary). For primary bibliographic entry see Field 2F. W87-09883

COMPUTER ANALYSIS OF WATER PUMP IN THE LLANO MINE (TERUEL, SPAIN) (ANALI-SIS POR ORDENADOR DE LOS BOMBEOS EN LA MINA LLANO (TEREUL-ESPANA)), Granada Univ. (Spain). Grupo de Trabajo de Hi-descenderio.

For primary bibliographic entry see Field 2F. W87-09885

GROUNDWATER HYDROLOGY - A TOOL FOR MINE PLANNING, OPERATION AND ABANDONMENT, Idaho Univ., Moscow. Coll. of Mines and Earth

Resources.
D. R. Ralston, B. D. Trexler, and R. E. Williams.
IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterrancos), Volumes I and II, 1984. SIAMOS 78. p 1081-1094, 5 fig. 2 ref.

\*Groundwater Descriptors: management, \*Groundwater, \*Groundwater move \*Mining engineering, \*Hydrology, \*Geoh-logy, Economic aspects, Planning, Mine plan movement, \*Geohydro-

Most hydrogeologic problems from mining activi-ties are related to the modification of existing thes are related to the modification of existing groundwater flow systems or the creation of new flow systems. Hydrogeology has not generally been included in past mineral resource development decisions because of : (1) the historical lack of economic incentive, (2) the lack of hydrogeologic understanding and data base, and (3) the lack of understanding and data base, and (3) the lack of expert hydrogeologists. It was concluded that hydrogeologic planning for mining today is less than fully effective because it is either responding to the specific short term stress on the part of industry or it is impact oriented planning done by public agencies. For hydrogeology to be an effective input into the mine decision process, it must be included in the economic consideration of mine planning. (Author's abstract) W87-09891

HOT WATER IN UNDERGROUND MINING, Washington Univ., Seattle. Dept. of Mining, Met-allurgical, and Ceramic Engineering. For primary bibliographic entry see Field 2F. W87-09893

GROUNDWATER PROBLEMS IN THE MINING DISTRICT OF IGLESIENTE (SAR-DINIA, ITALY), Politecnico di Torino (Italy). Ist. di Giacimenti Minerari e Geologia Applicata. M. Civita, T. Cocozza, L. Filippi, L. Musso, and

G. Perna.

In: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol-umes I and II, 1984. SIAMOS 78. p 1139-1155, 5 fig. 1 tab. 23 ref.

Descriptors: \*Mine drainage, \*Drainage engineering, \*Groundwater management, \*Groundwater level, \*Water level, \*Karst hydrology, Mineral industry, Groundwater, Pumping, Sardinia, Italy.

In Iglesinte, southwest Sardinia, there is an important orebearing district. The ores occur in the carbonate rocks of the Lower Cambrian. The Cambrian sequence was folded and faulted by the Caledonian, Hercynian and Alpine orogenies, with remobilization of the mineral deposits and the development of various karstic cycles. Large quantities of groundwater posed problems for mining. At present mining extends down to -300 meters. The 1500 liters/second pumped off at present are slightly briny. Research is now underway to allow deepening of the mines and of the water table level. (Author's abstract)

DRAINAGE IN SPANISH MINING (EL DESA-GUE EN LA MINERIA ESPANOLA), Rios Rosas, Madrid (Spain). L. Cuadra e Irizar, and J. Prado Calzado. IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol-umes I and II, 1984. SIAMOS 78. p 1157-1167.

Descriptors: \*Mine drainage, \*Drainage practices, \*Drainage engineering, \*Drainage systems, \*Data collections, \*Data interpretation, Spain, Underground mines, Minerals, Open mines.

The mine drainage systems in Spain are reviewed; the most important mines of both the underground and open-cut types of the most representative minerals were included. The broad coverage of different minerals and working systems provides a close indicator of national average data. The conclusions take into consideration standard values in the daily flow, upper values at high load conditions, the actual power used in the service, and the percentage of it related to the total power capacity of the mine. (Wood-PTT) (Wood-PTT)

WATER-ADIT GALLERIES IN THE VOLCAN-IC MASSIF OF FAMARA (LANZAROTE, CANARY ISLAND) (LAS MINAS DE CAPTA-CION DE AGUA EN EL MACIZO VOLCANICO DE FAMARA (LANZAROTE, ISLAS CANAR-TAS)),

saria de Aguas del Pirineo Oriental, Barcelona (Spain). F Custodio

E. Custodio.

IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volumes I and II, 1984. SIAMOS 78. p 1169-1194, 7

Descriptors: \*Groundwater management, \*Water management, Famara, Canary Islands, Permeability, Flow discharge, Water storage, Permeability coefficient, Storage coefficient, Drainage, Anisot-ropy, Saline water, Mathematical equations.

The water abstraction mines in the Famara volcanic massif mainly on the water reserves contained in a low permeability formation. They are uncommon a low permeability formation. They are uncommon abstraction works, from which many observation data were accumulated. The study of these data is a pilot work for similar massifs. Study of discharge and water chemistry yields a mean permeability less than 1 meter/day and frequently less than 0.01 meter/day. The storage coefficient after slow drainage may exceed 10 per cent in tabular basalts of miocene age as deep as 600 meters below the revowld surface. Anisotropy is seven important. The ground surface. Anisotropy is very important. The water is saline. Its composition is a function of climate and reflects a very high underground residence time. (Author's abstract)

W87-09897

DRYING UP THE LIMONITIC MINERAL IN THE SIERRA MENERA MINES (TERUEL AND GUADALAJARA, SPAIN) (SECADO DEL MINERAL LIMONITICO DE LOS YACIMIENTOS DE LA SIERRA MENERA (TERUEL Y GUADA-LAJARA, ESPANA), Granada Univ. (Spain). Grupo de Trabajo de Hi-

drogeologia.
For primary bibliographic entry see Field 2F.
W87-09899

DEEP DEPRESSION OF THE PIEZOMETRIC LEVEL IN THE THERMAL SPRING OF TE-PLICE (NORTHWESTERN BOHEMIA, CZECHOSLOVAKIA), DUE TO OPEN PIT EXCAVATION OF LIGNITE (L'ABAISSEMENT PROFOND DU NIVEAU PIEZOMETRIQUE DES SOURCES THERMALES DE TEPLICE (NORD-OUEST DE LA BOHEME, TCHESCOSLOVAQUIE) AU COURS DE L'EXPLOITATION DE LIGNITE A CIEL OUVERT), VISOKA SKOLA BARSKA. OSTRIVA (ČZECHOSIOVAKIA).

oka Skola Banska, Ostrava (Czechoslovakia). Homola.

In: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol-umes I and II, 1984. SIAMOS 78. p 1233-1248, 3

Descriptors: \*Groundwater management, \*Groundwater, \*Thermal water, \*Drainage engi-neering, \*Mine drainage, \*Coal mining, \*Ground-water level, \*Thermal springs, Water management, Groundwater recession, Pumping, Piezometric head, Safety, Teplice, Czechoslovakia, Lignite.

Since 1896 the groundwater level has been de-pressed 23-30 meters below the natural piezometric surface in order to ensure the thermal water supply for the Teplice Spa and the safety of the brown coal miners in the vicinity of Duchcov in case of a possible underground water eruption. Open pit mining is planned for future coal extraction. It will be necessary to depress the piezometric surface of the groundwater an additional 80-90 meters so that the underground runoff of thermal water does not increase by more than 100%, and so that the temperature of rocks within the zone of thermal water accumulation does not drop during a period of 15 years of water pumping by more than 2 C. (Author's abstract) W87-09901

WATER CAPACITY OF ABANDONED WORK-INGS IN UNDERGROUND COAL MINES. Glowny Inst. Gornictwa, Katowice (Poland)

Glowny and Glowny and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volumes I and II, 1984. SIAMOS 78. p 1291-1301, 1

Descriptors: \*Groundwater management, \*Water supply, \*Drainage engineering, \*Mine drainage, \*Coal mines, \*Groundwater storage, \*Groundwater, \*Data interpretation, \*Mathematical equations, Water management, Water capacity coefficient, Rock properties.

In underground coal mines there is a lot of water reservoirs in parts of old workings having no gravitational outlets, whose capacity reach hun-dreds of thousands of cubic meters. They represent dreds of thousands of cubic meters. They represent the serious hazard of mining work carried out in their proximity, because, in some circumstances, they cause the risk of water inrush into active workings. The only reliable way to eliminate this wer hazard is the dewatering of old workings by letting off the water by gravity or by pumping it out. The quantity of water being held in old work-ings may be calculated by multiplying the volume of the mined out coal bed by the water capacity coefficient. On the basis of investigations carried coefficient. On the basis of investigations carried out in mines and in laboratories, equations were established which permit the determination of the mean values of the water capacity coefficient depending on the mining method used, the depth at which old workings are situated, or rock pressure and on the quality of material used for stowing the old workings. (Author's abstract) coefficient. On the basis of investigations carried

CORRECTION OF CLAY SLOPES BY MEANS OF THE EXECUTION OF UNDERGROUND DRAINAGE NETWORKS (CORRECCION DE LADERAS ARCILLOSAS MEDIANTE LA EJECUCION DE PANTALLAS DRENANTES SUBTERRANEAS),

Empresa Constructora S.A., Madrid Agroman (Spain).

(Spain).
A. Eraso.
IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterrancos), Volumes I and II, 1984. SIAMOS 78. p 1323-1329, 2

Descriptors: \*Slope stabilization, \*Groundwater management, \*Clays, \*Subsurface drains, \*Drain-age systems, Subsurface drainage, Drains, Drain-age, Drainage practices, Soil types, Spain.

The problems of slumping of clay slopes which frequently affect civil works in southern Spain are studied. A technique involving underground curtain drains is developed which resolves the problem by modifying the causes using a combination of other well-known techniques. Its success lies in its simplicity and use of common sense. In all cases, the problems of the problems of the problems of the problems of the problems. the results were completely successful; the life of the curtain drains is still unknown since the oldest

#### Field 4-WATER QUANTITY MANAGEMENT AND CONTROL

#### Group 4B-Groundwater Management

has been functioning trouble-free for four years. (Author's abstract) W87-09907

PUTTING THE GROUNDWATER MONITOR-ING PIECES TOGETHER,
Pirnie (Malcolm), Inc., White Plains, NY. For primary bibliographic entry see Field 5G. W87-09936

#### 4C. Effects On Water Of Man's Non-Water Activities

HANGINGWALL DEWATERING AT MUFU-LIRA DIVISION OF ROAN CONSOLIDATED MINES LIMITED, ZAMBIA,

Roan Consolidated Mines Ltd., Mufulira (Zambia). Mufulira Div.

For primary bibliographic entry see Field 2F.

DEWATERING AND SETTLEMENT IN THE BANK COMPARTMENT OF THE FAR WEST RAND, SOUTH AFRICA,

Imperial Coll. of Science and Technology, London (England). Dept. of Geology (England). Dept. of Geology.

M. H. de Freitas, and J. F. Wolmarans

In: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol-umes I, 1984. SIAMOS 78. p 619-635, 9 fig, 12 ref.

Descriptors: \*Subsidence, \*Dewatering, \*Karst hydrology, \*Mining engineering, \*Embankments, \*Subsurface drainage, Geohydrology, Groundwater movement, Stability analysis, Sinsk, Karst, Geologic fractures, Groundwater level, Drainage engineering, Geology, Permeability coefficient.

The common form of settlement that accompanied the dewatering of karstic dolomites above the mines in the Bank Compartment is illustrated. De-tailed surveys of settlement and water levels have tailed surveys of settlement and water levels have been used to study the time dependency of settle-ment, illustrations of which are provided. A test embankment, built to load an area where settle-ment had ceased, produced no further settlement. It is concluded that settlement time curves, when used with a knowledge of basic subsurface condi-tions, provide a reliable basis from which to assess present day surface stability. Ground above faults and sink holes requires special assessment. (See also W87-09568) (Author's abstract)

METHODOLOGY AND APPLICATION OF ANALYSING ROCK-WATER INTERACTION ENDANGERING MINES.

Mining Development Central Inst., Budapest (Hungary). For primary bibliographic entry see Field 8E. W87-09607

CAVING OF A COAL SEAM UNDER KAMP-TEE AQUIFERS OF INDIA,

Central Mining Research Station, Dhanbad (India). For primary bibliographic entry see Field 2F. W87-0960

APPLICATION OF NON-POINT SOURCE RE-SPONSE FUNCTIONS TO GENERAL URBAN LAND USES.

Catholic Univ. of America, Washington, DC. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W87-09751

ALLUVIAL STREAMBED DEGRADATION, Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 2J.
W87-09781

SLACK-WATER DEPOSITS AND THE MAGNI-TUDE AND FREQUENCY OF FLASH FLOODS, EASTERN KENTUCKY, Kentucky Water Resources Research Inst., Lex-

For primary bibliographic entry see Field 2E. W87-09791

WATER QUALITY DATA FOR STREAMS IN THE UPPER NORTH FORK OF THE GUNNI-SON RIVER, COLORADO,
Geological Survey, Denver, CO. Water Resources

For primary bibliographic entry see Field 5B. W87-09807

GROUND-WATER DATA FOR THE HANNA AND CARBON BASINS, SOUTHCENTRAL WYOMING, THROUGH 1980,

Geological Survey, Cheyenne, WY. Water Resources Div.

For primary bibliographic entry see Field 2F. W87-09823

EFFECTS OF SURFACE MINING ON STREAMFLOW, SUSPENDED-SEDIMENT, AND WATER QUALITY IN THE STONY FORK DRAINAGE BASIN, FAYETTE COUNTY, DRAINAGE BAS PENNSYLVANIA,

Geological Survey, Pittsburgh, PA. Water Resources Div. For primary bibliographic entry see Field 5B. W87-09857

EFFECTS OF POTENTIAL SURFACE COAL MINING ON DISSOLVED SOLIDS IN OTTER CREEK AND IN THE OTTER CREEK ALLUVI-AL AQUIFER, SOUTHEASTERN MONTANA, Geological Survey, Helena, MT. Water Resources

Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 85-4206, 1985. 52 p, 4 fig, 23 tab, 43 ref, 2

Descriptors: \*Coal mines, \*Water quality, \*Water pollution sources, \*Montana, \*Powder River basin coal region, Hydrology, Coal mining effects.

Otter Creek drains an area of 709 square miles in the coal-rich Powder River structural basin of southeastern Montana. The Knobloch coal beds in the Tongue River Member of the Paleocene Fort Union Formation is a shallow aquifer and a target for future surface mining in the downstream part of the Otter Creek basin. A mass-balance model was used to estimate the effects of potential mining on the dissolved solids concentration in Otter Creek and in the alluvial aquifer in the Otter Creek valley. With extensive mining of the Knobloch coal beds, the annual load of dissolved solids to Otter Creek at Ashland at median streamflow Otter Creek at Ashland at median streamflow could increase by 2,873 tons, or a 32-percent increase compared to the annual pre-mining load. Increased monthly loads of Otter Creek, at the median streamflow, could range from 15 percent in February to 208 percent in August. The post-mining dissolved solids load to the subtrirgiated part of the alluvial valley could increase by 71 percent. The median dissolved solids concentration is the subtrigated part of the could be concentration. in the subirrigated part of the valley could be 4,430 milligrams per liter, compared to the pre-mining median concentration of 2,590 milligrams per liter. Post-mining loads from the potentially mined landrost-mining loads from the potentially mined land-scape were calculated using saturated-paste-extract data from 506 overburdened samples collected from 26 wells and test holes. Post-mining loads to the Otter Creek valley likely would continue at increased rates for hundreds of years after mining. If the actual area of Knobloch coal disturbed by mining were less than that used in the model, post-mining loads to the Otter Creek valley would be proportionally smaller. (USGS) W87-09864

DEEP DEPRESSION OF THE PIEZOMETRIC LEVEL IN THE THERMAL SPRING OF TE-

(NORTHWESTERN CZECHOSLOVAKIA), DUE TO OPEN PIT EX-CAVATION OF LIGNITE (L'ABAISSEMENT PROFOND DU NIVEAU PIEZOMETRIQUE DES SOURCES THERMALES DE TEPLICE DES SOURCES THERMALES DE TEPLICE (NORD-OUEST DE LA BOHEME, TCHESCOS-LOVAQUIE) AU COURS DE L'EXPLOITA-TION DE LIGNITE A CIEL OUVERT), Vysoka Skola Banska, Ostrava (Czechoslovakia). For primary bibliographic entry see Field 4B. W37-09901

IMPLICATIONS OF GRAVEL EXTRACTION ON GROUNDWATER CONDITIONS, Birmingham Univ. (England). Dept. of Geological

W. Lloyd.

In: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volumes I and II, 1984. SIAMOS 78. p 1249-1264, 8 fig. 4 ref.

Descriptors: \*Gravel mining, \*Gravel, \*Ground-water availability, \*Groundwater depletion, \*Groundwater movement, \*Groundwater pollu-tion, \*Groundwater, Construction materials, United Kingdom, Flow pattern, Model studies, Disiried medalom.

The mining of gravel for construction is a major industry in the United Kingdom. A large proportion of the gravel extracted is from alluvium in river valleys, where groundwater abstraction for water supply purposes is important and farming is extensive. Gravel operations affect the groundwaters. extensive. Gravel operations affect the groundwar-er flow patterns on a short term basis when dry working is carried out and on a long term basis when poor permeability back-filling is used. The effects of gravel operations causing derogation of wells, pollution and water-logging of farm land are outlined. A digital model is used to illustrate the degree of permanent effects under gravel back-filling in a valley. (Author's abstract) W87-09902

GROUNDWATER PROBLEMS CAUSED BY EXCAVATION OF BUILDING BASEMENT FROM THE VIEWPOINT OF NATURE CONSERVATION,

Tohoku Univ., Sendai (Japan).

H Okutsu IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol-umes I and II, 1984. SIAMOS 78. p 1275-1290, 13

Descriptors: \*Construction effects, \*Groundwater level, \*Groundwater depletion, \*Groundwater recession, Construction, Japan, Sendai, Water level, Groundwater, Trees, Wells, Well function.

Groundwater problems are discussed including: (1) the influence of excavation for building basements (-9 to-17 meters) recorded by automatic gages and by damage to on the Zelkova trees planted along the road sides as the symbol tree of Sendai City; (2) payments for damage to wells affected by payments for damage to wells affected by the lowering of the groundwater table caused by the excavation, and (3) future groundwater problems and protection from the viewpoint of nature conservation. (Author's abstract) W87-09904

HYDROLOGIC LAND USE CLASSIFICATION USING LANDSAT, Hydrologic Engineering Center, Davis, CA. For primary bibliographic entry see Field 7B. W87-09991

#### 4D. Watershed Protection

VARIABLE SOURCE AREAS OF WATERSHED RUNOFF IN A SMALL FOREST WATERSHED:

Washington State Univ., Pullman. Dept. of Forestry and Range Management.
D. R. Satterlund. Available from the National Technical Information

#### Identification Of Pollutants-Group 5A

Service, Springfield, VA 22161, as PB86-157393/ AS. Price codes: A03 in paper copy, A01 in micro-fiche. State of Washington Water Research Center, Pullman. Project Completion Report, June 1985. 39 p. 20 fig. 2 tab, 35 ref. Contract No. 14-08-0001-G940. USGS Project No. G940-04 (A-128-WASH

Descriptors: \*Rainfall-runoff relationships, \*Snowmelt, \*Washington, Forest watersheds, Watershed management, Forests.

Examination of a small mountain watershed occupied by grand fir (Abies grandis), western redcedar (Thuja plicata), and western hemlock (Tsuga heterophylla) habitat types in northern Idaho revealed that 80 percent of the time, less than 5 percent of its area would generate runoff in response to rain or snowmelt. The extent and location of active source areas were only moderately well-correlated with the extent and location of the tion of active source areas were only moderately well-correlated with the extent and location of the live stream system. Although a detailed vegetation study has not been undertaken, observations suggest that persistent source areas may be well-correlated with vegetation, which indicates the presence of available moisture throughout most of the growing season. (Satterlund-WSU) W87-09794

USING TIME DOMAIN REFLECTOMETRY TO MEASURE FROST DEPTH AND FROZEN WATER CONTENT IN SOIL, Washington State Univ., Pullman. Dept. of Agron-omy and Soils. For primary bibliographic entry see Field 7B. W87-09795

CORRECTION OF CLAY SLOPES BY MEANS OF THE EXECUTION OF UNDERGROUND DRAINAGE NETWORKS (CORRECCION DE LADERAS ARCILLOSAS MEDIANTE LA EJE-CUCION DE PANTALLAS DRENANTES SUB-

Agroman Empresa Constructora S.A., Madrid For primary bibliographic entry see Field 4B. W87-09907

### 5. WATER QUALITY MANAGEMENT AND PROTECTION

#### 5A. Identification Of Pollutants

ORGANIC COMPONENTS IN BULK AND WET-ONLY PRECIPITATION, Oregon State Univ., Newport. Marine Science Center.

M. A. Mazurek, and B. R. T. Simoneit. CRC Press, Boca Raton, Florida. 1986. 140 p.

Descriptors: \*Organic compounds, \*Precipitation, \*Pollutant identification, Air pollution, Information exchange, Data interpretation, Data collec-

Recent investigations of rain, snow, fog, dew, and Recent investigations of rain, snow, fog, dew, and cloud water have continued to study precipitation with regard to air pollution monitoring, to geochemical nutrient cycling, and to the atmospheric processes of nucleation and washout. Despite the sustained interest in the organic chemistry of precipitation, no reports have presented a compilation of concentration data for the various species identified, nor of the method which have been utilized in the collection and identification of the organic components. This survey has been conducted in order to meet this research need, but with the overall objective of providing a basis for the foroverall objective of providing a basis for the for-mulation of standard collection and analytical methodologies to be used in the quantitative analy-sis and identification of trace level organic species contained in precipitation samples. Chemical speciation, bulk organic constituent determinations, sampling and storage techniques, and analytical methodologies have been summarized into tables for purposes of qualitative comparisons, since the heterogeneities of the methods applied for collec-

tion and analysis prevent the direct quantitative comparison of these data. To date, there has been no systematic evaluation of the sampling and measurement protocols which have been utilized in the assessment of precipitation organic components. Data interpretation for both historical accounts and contemporary determinations becomes an ambiguous and arbitrary process in the absence of established and well-defined procedures. Fundamentally, the problem of data comparability is related to the intrinsic nature of precipitation events. Therefore, precipitation sampling is a time-averaging procedure that is operative over a specific receptor area. As such, the data must necessarily relate the factors of sampling duration and of collector surface area to the determined levels of species loadings or concentrations. The foregoing precipitation chemical data of organic constituents as an empirical data base that can provide a basis for future investigations of organic chemical studies of precipitation is presented. It is concluded that the aim of this survey has been to assimilate precipitation data relating to the organic fraction. Review of the various research efforts has demonstrated the substantive lack of consistent methodology for sample collection, preservation, storage, analysis, and data interpretation. Of necessity. strated the substantive lack of consistent methodology for sample collection, preservation, storage, analysis, and data interpretation. Of necessity, future research must address this deficiency, and provide a new integrated point of departure from which subsequent investigations of precipitation organic chemistry may logically advance. (Lantz-PTT)
W87-09628

SAMPLING DESIGN FOR RESERVOIR WATER QUALITY INVESTIGATIONS, Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab. For primary bibliographic entry see Field 7A. W87-09632

EFFECTS OF SELECTED SAMPLING EQUIP-MENT AND PROCEDURES ON THE CON-CENTRATIONS OF TRICHLOROETHYLENE AND RELATED COMPOUNDS IN GROUND WATER SAMPLES,

Geological Survey, Syosset, NY. Water Resources Div. For primary bibliographic entry see Field 7B. W87-09671

EVALUATION OF A FLUORESCENT ANTI-BODY TECHNIQUE FOR THE RAPID ENU-MERATION OF BACTEROIDES FRAGILIS GROUP OF ORGANISMS IN WATER,

Norges Tekniske Hoegskole, Trondheim. Div. of Hydraulic and Sanitary Engineering. L. Fiksdal, and J. D. Berg. Journal of Applied Bacteriology JABAA4, Vol. 62, No. 4, p 377-383, April 1987. 5 fig, 1 tab, 14 ref.

Descriptors: \*Analytical methods, \*Fluorescent antibody technique, \*Bacteroides, \*Water analysis, Feces, Coliforms, Disinfection, Public health.

The Bacteroides fragilis group has been evaluated as a prospective rapid indicator of fecal contamina-tion of water. Fluorescent antibody (FA) stained as a prospective rapid indicator of teem contamina-tion of water. Fluorescent antibody (FA) stained B. fragilis group bacteria were enumerated micro-scopically and compared with fecal coliform or Escherichia coli counts as indicators of fecal con-face waters (raw drinking water and known con-taminated water). Laboratory disinfection experi-ments with ozone, chlorine and u.v. radiation were also performed. Bacteroides FA counts specifically detected recent human fecal contamination in field samples in 2-3 h. Samples with a high content of particulates or debris limited the sensitivity to about 10 FA counts/ml. Viable counts showed that the sensitivity to all three disinfection agents was essentially the same for Bacteroides and E. coli. Fluorescent antibody counts of Bacteroides, con-versely, were not altered by any of the agents. Therefore, the Bacteroides FA method is not rec-ommended for routine monitoring but may be ommended for routine monitoring but may be useful for cases where extensive human fecal contamination is suspected (e.g. pipeline rupture or pollution of recreational water) and where rapid remedial action must be taken to protect the public health. (Author's abstract)

CORRELATION DETECTORS FOR SELEC-TIVE DETECTION OF POLLUTANTS IN NAT-URAL WATERS

URAL WATERS, Georgia Univ., Athens. Dept. of Chemistry. J. L. Anderson. Available from the National Technical Information Service, Springfield, VA 22161, as PB87-179545/ AS. Price codes: A05 in paper copy, A01 in micro-fiche. Environmental Resources Center, Georgia Institute of Technology, Atlanta. Report No. ERC 02-86, July 1986. 90 p, 6 tab, 21 fig, 55 ref. Con-tract No. 14-08-0001-G-1011. USGS Project No. G1011-02.

Descriptors: \*Pollutant identification, \*Electrodes, \*Water analysis, \*Correlation detectors, \*Electrochemistry, \*Spectrophotometry, Thin-layer flow

Theory was developed and experimentally tested for the response of amperometric electrochemical detectors in thin-layer flow channels, and theory was developed and preliminary experiments initiated for the response of spectroelectrochemical correlation detectors in thin-layer flow channels. The theory for amperometric response was evaluated experimentally for several designs of arrays of thin strip microelectrodes in series on one wall of a flow channel, with long axes perpendicular to flow. The electrode arrays were fabricated microlithographically, using gold conductors on silicon dioxide-covered silicon wafers, and platinum conductors on glass or quartz substrates. Experiments were carried out using flow injection methodology with sufficiently large injected volume to insure attainment of steady-state response. Experimental Theory was developed and experimentally tested attainment of steady-state response. Experimental response was in excellent agreement with theoretical prediction, for a series of uniformly spaced arrays of gold microelectrodes with widely varyarrays of gold microelectrodes with widely varying spacing and number of electrodes. Optimum
progression of microelectrode spacing across the
array was investigated theoretically. It was shown
that the optimum geometry is a uniform array of
strip electrodes of equal size and constant spacing.
Experimental results support the theoretical conclusion. Theory was developed for the correlation
detector based on electrochemical and spectrophotometric signals generated simultaneously in thinlayer detector cell. The optimum geometry for the
spectrophotometric optical beam was evaluated
based on signal/noise considerations, assuming that
shot noise was the dominant noise source. Optimum response is predicted for illumination parallel
to the electrode surface and either parallel or perto the electrode surface and either parallel or per-pendicular to flow. Preliminary experiments are qualitatively consistent with theoretical predic-tions. (Anderson-Univ of Georgia) W87-09376

HYDROGEOLOGIC AND WATER-QUALITY CHARACTERISTICS OF THE CRETACEOUS AQUIFER, SOUTHWEST MINNESOTA, Geological Survey, St. Paul, MN. Water Re-sources Div. For primary bibliographic entry see Field 7C. W87-09850

ESTIMATING IRON AND ALUMINUM CON-TENT OF ACID MINE DISCHARGE BY USE OF ACIDITY TITRATION CURVES, Geological Survey, Harrisburg, PA. Water Resources Div. For primary bibliographic entry see Field 7B. W87-09854

PROPOSED APPLICATION OF AUTOMATED BIOMONITORING FOR RAPID DETECTION OF TOXIC SUBSTANCES IN WATER SUP-PLIES FOR PERMANENT SPACE STATIONS, Tennessee Technological Univ., Cookeville. For primary bibliographic entry see Field 7B. W87-09925

BIOLOGICAL TESTING TO CONTROL TOXIC WATER POLLUTANTS. vironmental Protection Agency, Washington,

#### Group 5A-Identification Of Pollutants

DC. Office of Water Enforcement. T. M. Wall, and R. W. Hanmer. Journal of the Water Pollution Control Federation JWPFA5, Vol. 59, No. 1, p 7-12, January 1987. 6

Descriptors: \*Bioassay, \*Water pollution control, \*Administrative agencies, \*Toxicology, \*Monitor-ing, \*Pollutant identification, Assay, Environmen-tal protection, Water quality standards, Water quality control, Water quality management, Or-ganic compounds, Effluents, Pesticides, Wastewater treatment, Wastewater facilities, Heavy metals, Computers, Automation.

The use of toxicity testing in the National Pollut-ant Discharge Elimination System (NPDES) is reviewed and examples are provided of how such reviewed and examples are provided of how such testing has improved regulatory control of toxicants discharged by industrial and municipal wastewater facilities. Topics discussed include wastewater facilities. Topics discussed include identifying corrective actions, and monitoring for effluent effects. It is concluded that toxicity testing can improve the assessment and control of water pollutants when used in conjunction with traditional analyses such as chemical-specific control programs and technical review of manufacturing processes and purification technology. In the next several years, the U.S. Environmental Protection Agency plans to increase the use of toxicity testing to control wastewater discharges. (Doria-PTT)

QUANTIFICATION OF ODOUR PROBLEMS ASSOCIATED WITH LIQUID AND SOLID FEEDLOT AND POULTRY WASTES, National Inst. for Water Research, Bellville (South Africa). Cape Regional Lab. A. J. du Toit. Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 31-41, 1987. 9 fig, 7 tab, 14 ref.

Descriptors: \*Feed lots, \*Odors, \*Animal wastes, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Rural areas.

To prove the validity of an odor complaint, a standard evaluation procedure, whereby selected odor compounds are monitored, is proposed for use of Health authorities. The technique determines the dispersion of specific compounds from a point source. Odor threshold limits, determined by specialists odor panels, are used to evaluate the seriousness of the problem. Thereafter, individual waste handling systems are isolated as possible point sources of offensive odors. If dispersion studies and high odor compound concentrations prove igh odor compound concentrations prove the validity of a complaint, individual sites are investigated to determine the identity of the malfunctioning handling phase(s) of a specific treat-ment system. Results of various parameters are related to offensiveness in this procedure. The practical and objective nature of this technique makes it particularly suitable for application in semi-rural environments where agricultural activi-ties have impinged in residential areas. (Author's abstract) W87-10047

COBALT DETERMINATION IN NATURAL WATERS USING CATION-EXCHANGE LIQUID CHROMATOGRAPHY WITH LUMINOL CHEMILUMINESCENCE DETEC-TION, Massach

setts Inst. of Tech., Cambridge. Dept. of Earth, Atmospheric and Planetary Sciences. For primary bibliographic entry see Field 7B. W87-10073

STABLE ISOTOPE DILUTION ANALYSIS OF HYDROLOGIC SAMPLES BY INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY, Geological Survey, Denver, CO. For primary bibliographic entry see Field 7B. W87-10074

IDENTIFICATION OF A METALLOTHION-EIN-LIKE, HEAVY METAL BINDING PRO-TEIN IN THE FRESHWATER BIVALVE, COR-

Virginia Polytechnic Inst. and State Univ., Blacks-Virginia Polytecinic Inst. and Gata Order. Surg. Dept. of Biology. F. G. Doherty, M. L. Failla, and D. S. Cherry. Comparative Biochemistry and Physiology (C) CBPCEE, Vol. 87, No. 1 p 113-120, 1987. 3 fig. 69

Descriptors: \*Pollutant identification, \*Heavy metals, \*Proteins, \*Bioindicators, \*Metallothionein, \*Clams, Tissue analysis, Population exposure.

The Asiatic clam, Corbicula fluminea, possesses a heat stable, heavy metal binding protein (HMBP) with an apparent molecular weight similar to that of rat liver metallothionein (MT). Significant inof rat liver metallothionein (M1). Significant increases (1.2-1.6-fold) in the concentrations of HMBP were observed following 30-day exposures to either temperature extremes (4 or 30 C) Cl (0.29 mg/L total residual Cl), or dissolved Zn (0.50 mg/L). Exposure to dissolved Cd (0.10 mg/L) for 30 days in the concentrate triples resulted in 18 and 18 mg/L total residual Cl). L). Exposure to dissolved Cd (0.10 mg/L) for 3d days in two separate studies resulted in 1.8- and 2.8-fold increases in HMBP levels. Exposure to dissolved Cd (< 0.01, 0.10, 0.59 and 0.99 mg/L) for 42 days resulted in the greatest increases in HMBP occurring at 0.10 mg/L. Together these results revealed that relative concentrations of MT-like HMBP in tissues of the freshwater Asiatic clam were differentially influenced by the type, concentration and duration of exposure to a stressconcentration and duration of exposure to a stressor. (Author's abstract) W87-10077

BIOLOGICAL SURVEILLANCE OF WATER QUALITY I. A COMPARISON OF MACROIN-VERTEBRATE SURVEILLANCE METHODS IN RELATION TO ASSESSMENT OF WATER QUALITY, IN A CHALK STREAM,

Freshwater Biological Association, Wareham (England). River Lab.
L. C. V. Pinder, M. Ladle, T. Gledhill, J. A. B. Bass, and A. M. Matthews.
Archiv fuer Hydrobiologie AHYBA4, Vol. 109, No. 2, p 207-226, April 1987. 5 fig, 9 tab, 15 ref.

Descriptors: \*Bioindicators, \*Chalk streams, nology, \*Macroinvertebrates, \*Sediments, \*Macro-phytes, Riffles, Water quality, Comparison studies,

Spring and autumn samples of macroinvertebrates were obtained from gravel, soft sediments and the macrophyte, Ranunculus calcareus, at a riffle site on a southern English chalk stream. Various diversity indices and pollution indices were applied to the data and comparisons made between the different substrata, sampling methods and levels of identification of the invertebrates. (Author's abstract)

#### 5B. Sources Of Pollution

ACID RAIN AND DRY DEPOSITION, Oklahoma Univ., Norman. Environmental and Ground Water Inst.

L. W. Canter. Lewis Publishers, Inc., Chelsea, MI. 1986. 370 p.

Descriptors: \*Dry deposition, \*Fallout, \*Acid rain, \*Water pollution, Model studies, Path of pollutants, Fate of pollutants, Environmental effects, Metals,

Acid rain has become an environmental concern of global importance within the last decade. As addi tional monitoring data are collected, industrialized nations and industrial areas within developing nations are recognizing the ubiquitous nature of this concern. Due to the movement of air masses over great distances, long-range transport and subse-quent deposition of precipitation acidity and dry quent deposition of precipitation actinity and dry atmospheric constituents are causing transboun-dary or transnational pollution to be included on the world's environmental agenda. A scientific/ technical approach should be used in developing an understanding of the causes, consequences, and corrective actions necessary to deal with acid rain and dry deposition. Due to the relative newness of this environmental concern, a large number of technical reports, papers, and conference proceedings are being published annually. This book contains a summary of such published information available in the mid-1980's. This book is organized into six chapters and eight appendices. Following an introductory chapter, Chapter 2 provides a summary of general information on the acid rain problem. Chapter 3 relates to the atmospheric formation, modeling, and long-range transport of acid rain constituents. Chapter 4 describes the multiple effects of acid rain on both terrestrial and aquatice ecosystems. Strategies for controlling, or at least ecosystems. Strategies for controlling, or at least minimizing, the acid rain problem are discussed in minimizing, the actor rain problem are uscussed in Chapter 5. Dry deposition of atmospheric pollut-ants is addressed in Chapter 6, with emphasis given to precipitation metals and organics. Abstracts of the 540 included references are divided into eight appendices as follows: general information on acid appendices as follows: general information on acturain, atmospheric reactions, atmospheric models, long-range transport of air pollutants, effects of acid precipitation, control strategies, dry deposition, and precipitation metals and organics. (Lantz-PTT) W87-09624

SALT WATER INTRUSION: STATUS AND PO-TENTIAL IN THE CONTIGUOUS UNITED STATES, Oklahoma Univ., Norman. Environmental and

Ground Water Inst.
S. F. Atkinson, G. D. Miller, D. S. Curry, and S. Lewis Publishers, Inc., Chelsea, MI. 1986. 390 p.

Descriptors: \*Saline water intrusion. \*Groundwater quality, \*Saline water, \*Groundwater pollution, Groundwater management, Salinity, Water quality control, Leaky aquifers, Aquifers, Tides, Pumping.

Salt water can move into fresh groundwater sup-plies as a result of overpumping in coastal and tidal areas, overpumping in noncoastal areas which overlay saline water, movement of saline water through leaky well casings, and via natural proc-esses such as tidal variations or drought. Salt water esses such as tidal variations or drought. Salt water intrusion into fresh groundwater can limit the uses of groundwater for agricultural, industrial, or domestic purposes. Due to the increasing demands for usage of groundwater resources in the contiguous United States, it is important to evaluate and control salt water intrusion into these valuable resources. This book provides a summary of the status and potential for salt water intrusion into groundwater in the continuous United States. groundwater in the contiguous United States.
While the focus is on resultant limitations in the agricultural usage of groundwater, the book is not limited to this singular limitation in resource usage. limited to this singular limitation in resource usage. The book is organized into five chapters and two appendices. Key chapters or chapter sections are included on the effects of salimity, sources of salt water intrusion, physical control methods, results of a survey of the national status of salt water intrusion and a surveying methodology for salt water intrusion, and a systematic methodology for considering current and future salt water intrusion problems by water resources aggregated sub-considering current and future salt water intrusion problems by water resources aggregated sub-considering the salt water intrusion. problems by water resources aggregated subareas. (Lantz-PTT)

STABILIZATION OF CADMIUM AND LEAD IN PORTLAND CEMENT PASTE USING A SYNTHETIC SEAWATER LEACHANT,

New Hampshire Univ., Durham. K. M. Campbell, T. El-Korchi, D. Gress, and P.

Bishop. Environmental Progress ENVPDI, Vol. 6, No. 2, p 99-103, May 1987. 5 fig, 1 tab, 11 ref.

Descriptors: \*Cadmium, \*Lead, \*Portland cement, \*Concrete technology, Seawater, Leachates, Cement, Concretes, Stabilization.

The seawater leachability of cadmium and lead sludges solidified in portland cement paste was investigated. The leachates of the wastes containing cadmium and lead were analyzed for metal contents using flame atomic absorption spectro-photometry (AAS) as well as pH and alkalinity. A control sample containing only portland cement paste was also leached to serve as a comparison. Results show that the total cadmium leached from the stabilized waste over a 50-day period was about 1.0% of the total cadmium added to the

#### Sources Of Pollution-Group 5B

paste. Lead was not detected in the leachate, how-ever, this could be due to physical and analytical interferences associated with lead. The pH and alkalinity data show that initially, hydroxide is leached from the waste and calcium carbonates are auxamity data show that initially, hydroxide is leached from the waste and calcium carbonates are formed on the particle surfaces. After a 50-day period, the pH and alkalinity of the waste leachates approach that of the seawater leachant. The microstructure of the waste samples was investigated using scanning electron microscopy (SEM), energy dispersive X-ray analysis (EDXA) and powder X-ray diffraction (XRD). The presence of lead did not have an effect on the hydrated structure of the portland cement paste, whereas cadmium seemed to create a more porous microstructure with abundant colloidal ettringite (a calcium sulfoaluminate compound often found in hydrated portland cement paste). Fixation of cadmium in portland cement paste, Pixation of cadmium in portland cement paste, whereas sulfate attack on the paste by seawater, which in turn leads to destructive cracking of the paste. It appears that cadmium release is related to the physical destruction of the portland cement paste. (Author's abstract)

RADON-222 CONCENTRATION AND AQUI-FER LITHOLOGY IN NORTH CAROLINA, North Carolina Univ. at Chapel Hill. Dept. of Environmental Sciences and Engineering. D. P. Loomis

Ground Water Monitoring Review GWMRDU, Vol. 7, No. 2, p 33-39, Spring 1987. 3 fig, 2 tab, 32

Descriptors: \*Radon, \*Groundwater, \*Lithology, \*North Carolina, \*Aquifers, Radioactivity, Geology, Population exposure, Prediction, Field tests.

The presence of the radioactive gas radon (Rn-222) in many groundwater supplies is a potentially significant source of public exposure to ionizing radiation. A wide range of radon concentrations has been measured in groundwater in North Carolina, including some far in excess of national average concentrations. North Carolina is geologically concentrations. North Carolina is geologically complex and groundwater radon concentrations vary considerably among the state's aquifers. The highest average radon concentrations occur in areas underlain by granites (geometric mean 5910 pCi/L), and the lowest occur in the Atlantic Coastal Plain region (48pCi/L). Average radon levels intermediate between these extremes are characteristic of the large areas of North Carolina underlain by greisses schists and metavolcanic underlain by gneisses, schists and metavolcanic rocks. Relative average radon concentrations in groundwater from the rock types surveyed are groundwater from the rock types surveyed are consistent with relative abundances of uranium, the parent element of radon, in these rocks. Although other geologic and hydrologic factors also have an effect, aquifer lithology is a useful predictor of the concentration of radon in groundwater. The occurrence of high radon concentrations in certain aquifer types, such as granites, shows that geologic factors should be considered in estimates of population exposure to radon, and that knowledge of nactors should be considered in estimates of population exposure to radon, and that knowledge of aquifer geology can help to predict groundwater radon concentrations in areas where field sampling has not been done. (Author's abstract) W87-09666

POTENTIAL FOR SOLUTE RETARDATION ON MONITORING WELL SAND PACKS AND ITS EFFECT ON PURGING REQUIREMENTS FOR GROUND WATER SAMPLING, FOR GROUND WATER SAMPLING, Oregon Graduate Center, Beaverton. Dept. of En-vironmental Science and Engineering. For primary bibliographic entry see Field 7B. W87-09667.

INTERCEPTOR TRENCHES FOR POSITIVE GROUND WATER CONTROL, Union Carbide Corp., Port Lavaca, TX. Polyofins Div

S. G. Gilbert, and J. J. Gress. Ground Water Monitoring Review GWMRDU, Vol, 7, No. 2, p 55-59, Spring 1987. 9 fig, 5 ref.

Descriptors: \*Water pollution control, \*Landfills, \*Waste dumps, \*Interceptor trenches, \*Groundwater control, \*Path of pollutants, \*Waste dispos-

al, Leaching, Construction methods, Excavation,

Drainage.

Interceptor trenches are an effective groundwater control method at waste management sites. Trenches may be installed without disturbing the wastes, and the withdrawal of groundwater recovers contaminants that have left the waste management perimeter. The rapid and steep depression of the piezometric surface on both sides of the trench is positive proof of a barrier to horizontal flow across the trench in the affected permeable units. Historically, the construction of interceptor trenches has been very difficult. A new and efficient installation method has been developed and successfully utilized for several applications at a petrochemical facility on the Texas coastal plain. Rapid and cost-effective installation is made possible by innovations in sump and trench construction and the tie-in between the two. The sump is constructed first using standard well construction techniques to drill a 96-inch diameter hole to contain the 42-inch diameter polyethylene pipe sump. A European designed and fabricated trenching machine then excavates the trench, inserts the drainage pipe and backfills with sand and/or gravel in one operation. A specially designed perforated pipe entry door built into the side of the sump age pipe and backfills with sand and/or gravel in one operation. A specially designed perforated pipe entry door built into the side of the sump barrel provides for efficient and safe connection of the drainage pipe to the specially designed collection sump. The effectiveness of interceptor trenches has been confirmed in full scale applications through the reversal of flow gradients and the prevention of continued horizontal migration of groundwater contaminants. (Author's abstract) W87-09669

FAULT CONTROLLED HYDROGEOLOGY AT

FAULT CONTROLLED HYDROGEOLOGY AT A WASTE PILE, Kaman Tempo, Santa Barbara, CA. B. Keller, E. Hoylman, and J. Chadbourne. Ground Water Monitoring Review GWMRDU, Vol, 7, No. 2, p 60-63, Spring 1987. 2 fig, 2 tab, 5

Descriptors: \*Waste disposal, \*Groundwater pollution, \*Groundwater movement, \*Path of pollutants, \*Groundwater regime, \*Geologic mapping, Drilling, Monitoring, Tracers, Leachates.

Geologic mapping, subsurface drilling and monitoring well data indicate the existence of a complex and irregular groundwater regime in the vicinity of a cement kiln dust pile on an inactive splay of the Garlock Fault System. Artesian flow, active seeps and water levels that are substantially higher than the elevation of apparent saturated conditions encountered during drilling show that groundwater flows upward in certain localized zones. Tracing of chemical indicator parameters characteristic of kiln dust leachate shows that the dust pile is not affecting the chemistry of nearby groundwater. (Author's abstract)

POLYCHLORINATED BIPHENYL DECHLOR-INATION IN AQUATIC SEDIMENTS, INALIUN IN AQUATIC SEDIMENTS, General Electric Co., Schenctady, NY. Research and Development Center. J. F. Brown, D. L. Bedard, M. J. Brennan, J. C. Carnahan, and H. Feng. Science SCIEAS, Vol. 236, No. 4802, p 709-712, May 1987. 2 fig., 1 tab., 19 ref.

Descriptors: \*Polychlorinated biphenyls, \*Sediments, \*Fate of pollutants, \*Biodegradation, \*Microbiological studies, Dechlorination, Isomers, Anaerobic conditions, Aerobic conditions, Bacteria.

The polychlorinated biphenyl (PCB) residues in the aquatic sediments from six PCB spill sites showed changes in PCB isomer and homolog (congener) distribution that indicated the occurrence of reductive dechlorination. The PCB dechlorinations exhibited several distinct congener selection patterns that indicated mediation by several different localized populations of anaerobic microorganisms. The higher (more heavily chlorinated) PCB congeners that were preferentially attacked by the observed dechlorination processes included all those that are either pharmacologically active or

persistent in higher animals. All the lower (less heavily chlorinated) PCB congeners formed by the dechlorinations were species that are known to be oxidatively biodegradable by the bacteria of aero-bic environments. (Author's abstract)

MASS ACCOMMODATION COEFFICIENT FOR HO2 RADICALS ON AQUEOUS PARTI-

l Center for Atmospheric Research, Boulder CO

M. Mozurkewich, P. H. McMurry, A. Gupta, and J. G. Calvert

Journal of Geophysical Research (D) JGRDE3, Vol. 92, No. 4, p 4163-4170, April 1987. 5 fig. 2 tab, 44 ref. NSF Grants ATM-851540 and EPA DW49931818-01-0.

Descriptors: \*Atmosphere, \*Radicals, \*Chemical reactions, \*Aerosols, \*Acid rain, \*Chemistry of precipitation, Copper, Ions, Humidity, Clouds, Diffusion, Hydrogen.

The rate of reaction of gas phase HO2 radicals The rate of reaction of gas phase HO2 radicals with a monodisperse, submicron aerosol was measured in a flow tube reactor at atmospheric pressure. At the relative humidity of the experiments (75%), the aerosol consisted of concentrated solution droplets of either LiNO3 or NH4HSO4. When the aerosol contained a sufficient amount of Cu(II) ions, reaction of HO2 with the aerosol was observed. The mass accommodation coefficient for HO2 on a new part particles was determined to served. The mass accommonation coefficient for HO2 on aqueous particles was determined to be greater than 0.2. This implies that in clouds HO2 mass transport will be limited by gas-phase diffusion and HO2 will be in equilibrium at the gas-liquid interface. Reactions of HO2 with Cu(I) and Cu(II) ions in submicron aerosols may have a significant role in converting atmospheric odd hy-drogen radicals into H2O2. (Author's abstract) W87-09699

MICROCOMPUTER-BASED FLUOROMETRIC DATA LOGGING SYSTEM FOR FLOW AND DISPERSION MEASUREMENTS,

University of Strathclyde, Glasgow (Scotland). Dept. of Physics. For primary bibliographic entry see Field 7C. W87-09706

INCIDENCE OF STAPHYLOCOCCUS AUREUS, COLIFORMS AND ANTIBIOTIC RE-SISTANT STRAINS OF ESCHERICHIA COLI IN RURAL WATER SUPPLIES IN PORT HAR-

IN RURAL WATER SUPPLIES IN PORT HAR-COURT, Rivers State Univ. of Science and Technology, Port Harcourt (Nigeria). Microbiology Div. For primary bibliographic entry see Field 5F. W87-09711

MUTAGENESIS OF THE METABOLITE OF NONIONIC DETERGENTS IN WATER, Howard Univ., Washington, DC. Dept. of Civil Engineering. For primary bibliographic entry see Field 5C. W87-09749

APPLICATION OF NON-POINT SOURCE RE-SPONSE FUNCTIONS TO GENERAL URBAN LAND USES, Catholic Univ. of America, Washington, DC.

Catholic Univ. of America, Washington, Dept. of Civil Engineering.

Oet. of Civil Engineering.

O. K. Young, and E. Neal.

Available from the National Technical Information
Service, Springfield, VA 22161, as PB87-172615/

AS. Price codes: A08 in paper copy, A01 in microfiche.

D.C. Water Resources Research Center,
Washington, DC. Report No. 74, June 1986. 162,

23 fig, 16 tab, 24 ref, 5 append. Contract No. 14-08-0001-G 1009. USGS Project No. G1009-05.

Descriptors: \*Nonpoint-source pollution, \*Water pollution sources, \*Urban runoff. \*Microcomputers, \*Model studies, Calibration, Runoff, Verification, Watershed data, Water quality, Frequency functions, Transfer functions.

#### Group 5B-Sources Of Pollution

A microcomputer based daily accounting model of runoff and pollutant emission from urban catch-ments was developed, calibrated, and verified by application to District of Columbia area watershed data. The results from the investigation indicate that the model is accurate and reliable. The model is easily implemented on a microcomputer and thus avoids the extensive time and costs associated with modeling urban water quality on mainframe commodeling urban water quality on maintrame com-puters, using existing complex simulation models. The model can be used to generate pollutant emis-sion frequency functions for small urban water-sheds that possess a range of different rainfall inputs and cultural factors. The developed simulation model was utilized in a Monte Carlo context to generate a large database on nonpoint-source emissions and associated urban land use attributes. Least squares regression was applied to the data-base to develop emission functions of land use and other physical independent variables. The resultant transfer function between rainfall watershed parameters and runoff and pollutant emissions is used without recourse to additional mathematical modeling. (Neal-Cath. Univ. of Amer.) W87-09751

AVAILABILITY AND DISTRIBUTION OF HEAVY METALS, NITROGEN, AND PHOS-PHORUS FROM SEWAGE SLUDGE IN THE PLANT-SOIL-WATER CONTINUUM.

Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agronomy.

B. D. Rappaport, J. D. Scott, D. C. Martens, R. B. Reneau, and T. W. Simpson.

Reneau, and 1. w. Simpson. Available from the National Technical Information Service, Springfield, VA 22161, as PB87-176269/ AS. Price codes: A06 in paper copy, A01 in micro-fiche. Virginia Water Resources Research Center Blacksburg, Bulletin 154, February 1987. 93 p, 16 fig. 27 tab. 129 ref.

Descriptors: \*Water pollution sources, \*Water pollution effects, \*Path of pollutants, \*Groundwater pollution, \*Heavy metals, \*Phytotoxicity, \*Land disposal, \*Soil, \*Sludge disposal, Cadmium, Copper, Mineralization, Nickel, Nutrient balance, age sludge utilization, Zinc.

Cd, Cu, N, Ni, P, and Zn availabilities to barley (Hordeum vulgare L.) and corn (Zea mays L.) grown on four sludge-amended soils using Acredale silt loan (Typic Ochraqualf), Bojace loamy soil (typic Hapludult), Davidson clay loam (Rhodic Paleudult), and Grose-close silt loam (Typic Hapludult) were determined. An aerobicaldigested sewage sludge from a treatment plant with major industrial inputs was dewatered for 2 on sandbeds. This sludge was applied at rates of 0, 42, and 84 dry Mg/ha to poorly drained Acredale soil and at rates of 0, 42, 84, 126, 168, and 210 dry soil and at rates of 0, 42, 84, 126, 168, and 210 dry mg/ha to well-drained Bojac, Davidson, and Grose-close soils. The 210 day Mg/ha sludge rate supplied 4.5 kg Cd, 750 kg Cu, 3350 kg N, 43 kg Ni, 6900 kg P, and 600 kg Zn/ha. A 14-day anaerobic N incubation study indicated that mineralization of sludge organic N varied from 9.2% at the 24 Mg/ha sludge rate to 4.2% at the 210 Mg/ha rate. Crop yields were not decreased by metal phytotoxity or P deficiency. Although there were increases in Cd, Cu, Ni, and Zn in plants grown on the sludge-amended soils, the metal concentrations were within the ranges of those reported for nonsludged soils. Levels of DTPA-extractable metals in the AP horizon of the soils provided a good indiludged soils. Levels of DTPA-extractable means in the AP horizon of the soils provided a good indication of the amounts of metals in the soils from sludge application. Relatively low correlations occurred between DTPA-extractable Cd, Cu, Ni and Zn and the respective metal concentrations in plant tissue. The DTPA-extractable Cd, Cu, Ni, and Zn concentrations in soils sampled from various concentrations in soils sampled from various depths indicated virtually no downward movement of these metals in the sludge-amended soils. Dilute double-acid extractable P in these samples indicated a small amount of P movement in only the sludge-amended Bojac and Davidson soils. The limited N mineralization of the sludge substantially reduced the potential for NO3(-) contamination of eventually sets. groundwater. (USGS) W87-09753

EVALUATING POTENTIAL GROUNDWATER CONTAMINATION FROM CONTAMINATED SOILS,

Murray State Univ., KY.
J. R. Pratt, P. V. McCormick, K. W. Pontasch, and J. Cairns.

Available from the National Technical Information Available from the National 1 echnical information Service, Springfield, VA 22161, as PB87-176277/ AS. Price codes: A03 in paper copy, A01 in micro-fiche. Virginia Water Resources Research Center, Blacksburg. Bulletin 155, March 1987. 30 p, 8 tab,

\*Leachate, \*Soil contamination, Descriptors: \*Leachate, \*Soil c \*Water pollution sources, \*To \*Groundwater pollution, \*Path of Daphnia, Microcosms, Toxicity, Soil. of pollutants.

Contamination of soils at toxic and hazardous waste sites can adversely affect groundwater and surface water. Water soluble materials can move in soil by leaching and percolation by runoff. This project evaluated the toxicity of leachable toxicants from seven soils, five of which were obtained from designated toxic or hazardous waste sites. Acidified, dechlorinated tap water was used to extract toxic materials from surface soils. Extracts extract toxic materials from surface soils. Extracts were used as complex mixtures in acute toxicity tests using Daphnia and in some chronic effect tests using microcosms. Three classes of effects were observed. Some leachates (including control soils) showed no toxicity. Some soil leachates had producests expute soxicity. (50.80% diluted leachats) moderate acute toxicity (50-80% diluted leachate) and no chronic toxicity. Very toxic soils showed both acute and chronic toxicity at <3% leachate. Toxicological evaluations of contaminants in waste site soils can provide information not available from chemical analyses and may be useful in verifying the effectiveness of cleanup effort. (USGS) W87-09754

PERSISTANCE OF THREE HALOGENATED ALIPHATIC GROUNDWATER CONTAMINANTS UNDER ANOXIC CONDITIONS, Michigan State Univ., East Lansing. Dept. of Civil

Engineering. R. B. Kapuscinski.

Available from the National Technical Information Available from the National Lechnical Information Service, Springfield, VA 22161, as PB86-157369/ AS, A04 in paper copy, A01 in microfiche. Michigan Water Research Institute, East Lansing, Michigan, August 1985. 64 p, 100 ref. Contract No. 14-08-001-G913. USGS Project No. G913-04.

Descriptors: \*Groundwater contamination, \*Biodegradation, \*Halogenated pesticides, \*Groundwater pollution, Halogens, Michigan.

Three halogenated compounds that are common groundwater contaminants were observed to un-dergo no appreciable transformation by soil microorganisms and an enrichment culture grown on menthanol and ethanol under anoxic conditions. Based upon these observations and published data, it is suggested that these compounds are not likely to be readily degraded in oxidized or moderately reduced groundwaters, perhaps because their transforming activity by indigenous microorganisms. (Kapuscinski-Univ. of Mich)

SPATIAL ANALYSIS OF MICHIGAN PUBLIC HEALTH DEPARTMENT NITRATE DATA, Michigan State Univ., East Lansing. Inst. of Water

Research.
F. M. D'Itri, K. M. Kittleson, and R. L. Kruska.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB86-157377/
AS, A02 in paper copy, A01 in microfiche. Michigan Water Research Institute, East Lansing, Completion Report, October 1985. 21 p, 2 append.
Contract No. 14-08-001-G913. USGS Project No.
G913-07.

Descriptors: \*Michigan, \*Groundwater pollution, \*Nitrates, \*Computer models, Groundwater, Contamination, Public health, Spacial distribution.

Michigan Public Health Department water quality data from groundwater municipal sources and lo-cation identifiers were input to a database manage-

ment system. Well locations and average nitrate values were extracted from the database in three time periods and input to a surface (contouring) routine that interpolated the data to yield pictures of trends in nitrate contamination over the space. (Kruska-Mich. St. Univ.)
W87-09758

CHEMIGATION; WATER QUALITY, IMPLICATIONS

Michigan State Univ., East Lansing. Dept. of Agri-

Michigan State Univ., East Lansing. Dept. of Agricultural Engineering.
T. L. Loudon, and L. E. Reese.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-157351/AS. Price codes: A04 in paper copy, A01 in microfiche. Michigan Water Research Institute, East Lansing, Michigan, 1985. 57 p. 81 ref. Contract No. 14-08-0001-G913. USGS Project No. G913-08.

Descriptors: \*Irrigation, \*Chemigation, \*Michigan, Groundwater, Nitrates, Lysimeters.

Chemigation is fast growing among irrigators. Most chemigation research has been conducted in the Southern and Midwestern United States. This the Southern and Midwestern United States. This project has been developed with objectives: 1. To investigate several aspects of irrigation machinery and chemical injection system geometry on uniformity and chemical efficacy when used for chemigation. 2. To investigate nitrogen movement within the root zone using different nitrogen appliance of the control of the within the root zone using untreath throgen appli-cation strategies (a) all preplant, (b) preplant and side-dress, and (c) all chemigation. 3. To investi-gate nitrogen leaching through the root zone under irrigated conditions. Two linear move irrigation, systems and one pivot were used for chemigation, and all systems tested produced excellent chemical and all systems tested produced excellent chemical efficacy. For all irrigation machines tested, it was observed that equipment modifications could better the performance of the system for chemigation by better designing the sprinkler packages for the soil type and system used. A linear move irrigation system produced an overall water distribution uniformity coefficient of 93.1%, and the same system produced a nonsoluble liquid chemical distribution uniformity coefficient of 20.6%; illustrating the need for additional research as to the engineering theory of chemication. Nitrate nithe engineering theory of chemigation. Nitrate nitrogen leaching concentrations of deep percolate as collected from the bottom of a weighing lysimeter had an average concentration of 23.4 mg/l. (Loudon-Mich. State Univ.) W87-09759

FLOW THROUGH CLAY LINERS: MODEL PREDICTION AND FIELD OBSERVATION, Wayne State Univ., Detroit, MI. Dept. of Civil For primary bibliographic entry see Field 5G. W87-09760 Engineering.

IDENTIFICATION AND MODELING THE IMPACT OF MARINE SHALE BEDROCK ON GROUNDWATER AND STREAM SALINITY: UPPER COLORADO RIVER BASIN,

Utah Center for Water Resources Research, Logan.

For primary bibliographic entry see Field 2K. W87-09765

BIOGEOCHEMISTRY OF THREE APPALACHIAN FOREST SITES IN RELATION TO STREAM ACIDIFICATION,

STREAM ACIDIFICATION,
Pennsylvania State Univ., University Park. Inst.
for Research on Land and Water Resources.
D. R. DeWalle, and W. E. Sharpe.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB86-151685/
AS. Price codes: A03 in paper copy, A01 in microfiche. Publication No. LW8510, September 1985.
37 p. 14 tab, 10 ref., 2 append. Contract No. 14-080001-G929-02. USGS Project No. G929-02.

Descriptors: \*Deposition, \*Acidic soils, \*Air pollution, \*Acid rain, \*Pennsylvania, \*West Virginia, Deciduous forest, Leaching, Lysimeters, Metals,

Sources Of Pollution-Group 5B

Wet fallout, bulk precipitation, throughfall and soil leachate chemistry were studied from November, 1984 at three Appalachian deciduous forest sites to determine the cause of differences in stream acidification. At one site on Fork Mrn. in northcentral West Virginia, where the stream exhibits little transient acidification during stormflows, soil leachate was found to be significantly less acidic and higher in dissolved calcium and magnesium. In contrast, on Peavine Hill in southwest Pennsylvania and Sand Mrn. in central Pennsylvania, where streams exhibit transient stormflow acidification, acidic soil leachate with high concentrations of dissolved manganese and aluminum were found. Thus, differences in stream acidification among sites seem to be in part caused by varying chemistry of soil water yielded to streams or groundwater reserves during storm periods. Differences in soil leachate chemistry among sites were attributed to higher atmospheric deposition of H+ at the acid stream sites and higher weathering rates at the Fork Mrn. site of the meager amounts of calcium and magnesium compounds found in sandstone and shale parent materials. Leaves and secondary xylem from trees at the acid stream sites exhibited lower calcium and higher manganese and lead concentrations than at the Fork Mrn. site. Soil and pulverized bedrock samples also showed greater acidity and lower exchangeable calcium and magnesium at the than at the Fork Mtn. site. Soil and pulverized bedrock samples also showed greater acidity and lower exchangeable calcium and magnesium at the two acid stream sites, than at the Fork Mtn. Finally, annual throughfall input of sulfate to the soil was found to be equal to or less than sulfate loss in soil leachate at all three sites; indicating no significant soil sulfate adsorption was occurring in these soils. This conclusion is supported by soil adsorption capacity measurements. Soils at all sites were vulnerable to cation leaching by mobile sulfate anions and cation leaching in these soils should respond to changes in levels of atmospheric sulfate deposition caused by changing atmospheric emissions of SO2. (DeWalle-Penn St. Univ.)

RECONNAISSANCE OF GROUND-WATER QUALITY IN THE U.S. VIRGIN ISLANDS, Caribbean Research Inst., St. Thomas, VI. Water

QUALITY IN THE U.S. VIRGIN ISLANDS, Caribbean Research Inst., St. Thomas, VI. Water Resources Research Center. M. Canoy, A. Knudsen, and R. Garcia. Available from the National Technical Information Service, Springfield, VA 22161, as PB86-170396/. AS. Price codes: A03 in paper copy, A01 in micro-fiche. Technical Report No. 24, September 1985. 33 p, 4 fig. 7 tab, 40 ref, append. Contract No. 14-08-0001-G875. USGS Project No. G875-03.

Descriptors: \*Groundwater quality, \*Virgin Islands, \*Groundwater resources, Baseline studies, Water quality, Coliforms, Water quality standards.

The U.S. Virgin Islands are faced with ever increasing demands for water and the response to these demands is calling into production groundwater supplies of dubious quality. To evaluate the seriousness of this problem, a cooperative study between the Caribbean Research Institute and the U.S. Geological Survey was done during 1984-84. In this study, 26 wells were sampled for physical, chemical, and microbiological parameters including salmity, temperature, ionic species, heavy metals, 128 critical organic pollutants, and the major microbiological species present. Results of this study indicate that the chemical quality of the groundwater, except for nitrate and total salinity in three wells, was acceptable. None of the 128 'priority pollutants' analyzed exceeded national standards. However, microbiological status of all wells were found to be very dubious. Three wells on St. John could pass the EPA coliform standard; however, five wells on St. Thomas-St. Croix were found free of potentially pathogenic bacteria. Conclusions of the study were that: 1. Chemically, the groundwater of the V.I. is of acceptable quality or can be treated to become acceptable, 2. Microbiologically, the groundwater is of dubious to poor quality due to contamination with feces and/or pathogenic bacteria. 3. Current standards, using fecal coliforms as indicators, are probably not useful in the V.I. and may be misleading. 4. Standards for both groundwater use and sewage (septicatank) facilities are not protecting the water and should be reviewed and revised. (Canoy-Virgin Island Coll.-WRRC) The U.S. Virgin Islands are faced with ever in-

W87-09768

HYDROGEOLOGIC AND GEOCHEMICAL EVOLUTION OF CONTAMINATED GROUND-WATER NEAR ABANDONED MINES, Wisconsin Univ-Madison. Water Resources

Center.
L. S. Toran, and K. R. Bradbury.
L. S. Toran, and K. R. Bradbury.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB86-168044
AS. Price codes: A03 in paper copy, A01 in microfiche. Technical Report WIS WRC 85-01, 1985. 34
p, 8 fig. 4 tab, 45 ref. Contract No. 14-08-0001G878. USGS Project No. G-878-03.

Descriptors: \*Wisconsin, \*Lead, \*Groundwater pollution, \*Path of pollutants, \*Zinc, \*Water pollu-tion sources, Aquifers, Mineral industry, Ground-water movement, Dewatering, Mine waters.

The zinc-lead mines near Shullsburg, Wisconsin operated since the turn of the century until they shut down in 1979. The mines are located in the Galena-Platteville formation, a carbonate aquifer that was dewatered during mining. While the rock was exposed to air, sulfide minerals in the surrounding rock were oxidized to sulfate. As groundwater re-entered after the mines closed, the sulfates dissolved, resulting in a serious groundwater contamination problem. Sulfate levels have reached over 26 mmols/L in some local wells and 11 home wells have been abandoned. Combining the results of numerous hydraulic head measurements with analyses of groundwater samples from the Galena-Platteville aquifer shows that sulfate contamination is relatively localized around the mine workings. Although active mining has not occurred for several years, a relict cone of depression remains in the water table above the mines. Consequently, groundwater flows radially inward to fill the cone of depression and to dilute the contaminated water, and contamination levels are gradually declining. Isotopic measurements tend to support this dilution scheme. By combining chemical studies with an understanding of groundwater flow in the area, our understanding of the direction and extent of contamination has increased. The consequences of the carbonate buffer on mechanisms of oxidation have also been addressed, which helps assess the potential impacts of future mine development. (Bradbury-Univ. of Wis-Mad.WRC)

HETEROGENEOUS ADSORPTION-DESORP-TION KINETIC EXPRESSIONS GOVERNING THE AVAILABILITY OF MICROCONTAMIN-ANTS IN GROUNDWATER, Wisconsin Univ.-Madison. Dept. of Water Chemis-

wisconsin Univ-Madison. Dept. of Water Chemistry.
E. C. Yost, and M. A. Anderson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-168119/AS. Price codes: A03 in paper copy, A01 in microfiche. Technical Report WIS WRC 85-01, Wisconsin Water Resources Center, Madison, 1985. 28 p, 8 fig. 25 ref. Contract No. 14-08-0001-G878. USGS Project No. G-878-04 and G942-04.

Descriptors: \*Adsorption, \*Groundwater contamination, \*Groundwater pollution, \*Path of pollutants, Groundwater, Model studies, Vadose water.

Results of an investigation of interfacial reactions between adsorbate molecules and goethite particles suspended in aqueous solutions are described here. Attention is focused on two findings which are significant in the area of microcontaminant movement in subsurface environments. The first of these is the effect of aggregation in describing the equilibrium and the kinetic behavior of the adsorption process. The second is the equilibrium and kinetics of salicylate adsorption on goethite (alpha-FeOOH) using a new in situ Fourier transform infrared spectroscopy technique. The first part of this report illustrates that the degree of aggregation influences the isoelectric pH of the solid absorbent, in this case goethite. The second portion of the report discusses the kinetics and equilibrium of salicylate adsorption on goethite. In addition, it is demonstrated how FTIR spectroscopy can be used to identify surface complexes which have

often been hypothesized, but never 'seen' with direct techniques. (USGS) W87-09783

MERCURY MOBILIZATION AND BIOMAG-NIFICATION RESULTING FROM THE FILL-ING OF A PIEDMONT RESERVOIR, Clemson Univ., SC. Dept. of Environmental Sys-

Clemson Univ., SC. Dept. of Environmental Systems Engineering.

A. R. Abernathy.

A vailable from the National Technical Information Service, Springfield, VA 22161, as PB86-157120/AS. Price codes: A04 in paper copy, A01 in microfiche. South Carolina Water Resources Research Institute, Clemson. Report No. 119, September 1985. 59 p. 10 fig. 11 tab, 46 ref. 5 append. Contract No. 14-08-0001-G-932. USGS Project No. G-932-07-SC.

Descriptors: \*Mercury, \*Heavy metals, \*Bioaccu-mulation, \*South Carolina, Biological magnifica-tion, Reservoirs, Methylmercury.

Mercury contained in flooded soil and vegetation mercury contained in flooded soil and vegetation can be mobilized upon flooding of a new reservoir. The mobilized mercury is accumulated by fish in the new reservoir, and concentrations of total mercury in muscle tissue of predatory fish such as largemouth bass, yellow perch, and other piscivorous species is likely to exceed 1.0 ppm within the first two years after the reservoir fills. The concenfirst two years after the reservoir fills. The concentrations of total mercury in Russell Reservoir (South Carolina) water were found to be less than in the Savannah River before impoundment, but the total mass of mercury in the impounded water was greater than could be accounted for by that brought in via the inflowing water. Concentrations of total mercury in fish continued to increase during the first 18 months after closure of the dam. (Abernathy-WRRI) W87-09787

ABATEMENT OF NITRATE POLLUTION IN GROUNDWATER AND SURFACE RUNOFF FROM CROPLAND USING LEGUME COVER CROPS WITH NO-TILL CORN,

Kentucky Water Resources Research Inst., Lex-

ington.
M. S. Smith, W. W. Frey, and J. J. Varco M. S. Smith, W. W. Frey, and J. J. Varco.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB87-159349.
AS. Price codes: A03 in paper copy, A01 in microfiche. Report No. 163, July 1986. 18 p. 8 tab, 16
ref. Contract No. 14-08-0001-G1019. USGS
Project No. G-1019-05.

Descriptors: \*Nitrates, \*Agricultural runoff, Agronomy, Cover crops, Leaching, Legumes, Fer-

Agricultural practices can have a significant impact on water quality. The effects of leguminous winter cover crops on leaching of nitrates from soil have been investigated in this project. Legume cover crops, by fixation of atmospheric N, can reduce the amount of fertilizer N required to produce summer grain crops. The methods initially used to evaluate cover crop effects on nitrate transport included suction probe lysimeters and measurement of nitrates in soil samples collected to a depth of 90 cm. These measurements demonstrated extreme spatial variability in nitrate distribution and water movement. This made it impractical to compare effects of different treatments. Soil transformations of legume and fertilizer N sources were compared using labelled amendments. Less of the vetch N was found in leachable forms and, after 2 and 3 months in soil, losses of vetch N were smaller than losses of fertilizer N. To resolve the problem of spatial variability and to make direct measurements of leaching, 16 lysimeters were constructed from 55 gallon drums. These were treated with either fertilizer or legume N. Early measurements show greater nitrate leaching with legume N due to the mulch effect reducing evaporative water removal. (Huffsey-KWRRI)

MATHEMATICAL MODELS OF SEDIMENT EFFECTS ON WATER RESOURCES SYSTEMS,

#### Group 5B-Sources Of Pollution

Mississippi Univ., University. Center for Computa-tional Hydroscience and Engineering. For primary bibliographic entry see Field 2J. W87-09805

WATER QUALITY DATA FOR STREAMS IN THE UPPER NORTH FORK OF THE GUNNI-SON RIVER, COLORADO,

Geological Survey, Denver, CO. Water Resources

J. M. Norris, and W. S. Maura. Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 85-190, 1985. 122 p, 1 fig, 77 tab.

Descriptors: \*Water quality, \*Colorado, \*Gunnison River, Data collections.

The upper reaches of the North Fork of the Gunnison River have been an area of active coal mining for many years. Recently, concerns about impacts of coal mining on surface-water quality have been raised. To answer these concerns, information on enisting, or background, water quality must be known. To obtain this information for the must be known. To obtain this information for the study area, a program for the synoptic collection of water quality data was established in 1982. Water quality data were collected on continuously flowing streams in the upper North Fork of the Gunnison River basin in 1982 and 1983. Each site was sampled repetitively as changes occurred in streamflow and specific conductance. (USGS) W87-09807

WATER-QUALITY DATA FOR 35 SITES, SEP-TEMBER, 1984, NEAR THE Y-12 PLANT, THE OAK RIDGE RESERVATION, TENNESSEE, Geological Survey, Nashville, TN. Water Re-

P I Pulliam

Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 85-553, 1985. 14 p, 2 fig, 6 tab, 7 ref.

Descriptors: \*Fate of pollutants, \*Groundwater Descriptors: "Fate of pollution, "Radioactive waste disposal, "Stream pollution, "Oak Ridge, "Tennessee, Nuclear wastes, Radioactive wastes, Waste disposal, Water waster, Waster sampling, Oak Ridge Reservation, Y-12 Plant, Roane County, Anderson County.

Water quality data were collected at 35 sites in the vicinity of the Y-12 Plant, Oak Ridge, Tennessee, on September 16 and 17, 1984. Concentrations of dissolved major and trace constituents were determined; field determinations of specific conduct ance, pH, temperature, alkalinity, and dissolved oxygen were made. Gross alpha and beta activity were determined for seven of the sites sampled. (USGS) W87-09810

WATER QUALITY OF THE CHARLOTTE HARBOR ESTUARINE SYSTEM, FLORIDA, NOVEMBER 1982 THROUGH OCTOBER 1984, Geological Survey, Tampa, FL. Water Resource Div.

For primary bibliographic entry see Field 2L. W87-09812

DATA ON SNOW CHEMISTRY OF THE CAS-CADE-SIERRA NEVADA MOUNTAINS. Geological Survey, Tacoma, WA. Water Resources Div. For primary bibliographic entry see Field 2K. W87-09814

PHYSICAL AND CHEMICAL DATA FOR THE SACRAMENTO RIVER AT RIO VISTA, CALI-FORNIA, JANUARY THROUGH MAY, 1983, Geological Survey, Menlo Park, CA. Water Resources Div.

D. D. Harmon, L. E. Schemel, S. W. Hager, and

Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 86-230, 1986. 26 p, 4 fig, 4 tab, 15 ref.

Descriptors: \*Water quality, \*Sacramento River, \*California, Streamflow, Specific conductance, Alkalinity, Suspended particulate matter, Dissolved inorganic nutrients, Rio Vista.

Physical and chemical data for the Sacramento River at Rio Vista, California, for the period of January to May, 1983 are presented in this report. Measurements include specific conductance, alkalinity, suspended particulate matter, and the dissolved inorganic nutrients; nitrite, nitrate plus nitrite, ammonium, dissolved silica, and ortho-phosphate. Numerical results are tabulated and details of the methods are described. (USGS) W87-09819

BACKGROUND HYDROLOGIC INFORMA-TION IN POTENTIAL LIGNITE MINING AREAS IN MISSISSIPPI, AUGUST 1985, Geological Survey, Jackson, MS. Water Resources

Div

Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 86-238, 1986. 16 p, 5 ill, 3 tab, 10 ref.

Descriptors: \*Water quality, \*Lignite, \*Mining, \*Mississippi, Land use, Marshall County, Lafayette County, Benton County, Union County, Tippah

The U.S. Geological Survey, in cooperation with the Mississippi Department of Natural Resources, Bureau of Geology, is conducting a hydrologic data collection program in potential lignite-pro-ducing areas in the outcrops of the Wilcox Group in Mississippi. During August 1985, hydrologic data were collected at a total of 15 stream sites in data were collected at a total of 15 stream sites in Benton, Lafayette, Marshall, and Union Counties. Main channel widths ranged from approximately 30 feet to 115 feet. Stream depths during low-flow periods were shallow, generally less than 1.0 foot at most sites. Discharges ranged from 0.04 to 74.8 cubic feet per second. The specific conductance of stream water ranged from 28 to 78 microsiemens and dissolved-solids concentrations ranged from 24 to 59 milligrams per liter. Turbidity values were 20 units or less. Chromium and copper concentrations in bottom material samples ranged from below detection limits (1 microgram per gram) to 5 microgram per gram and mercury concentrations ranged from 0.01 to 0.08 microgram per gram. (USGS)
W87-09831

MAP SHOWING THE NUMBER OF GIARDIA CYSTS IN WATER SAMPLES FROM 69 STREAM SITES IN THE SIERRA NEVADA,

Geological Survey, Sacramento, CA. Water Re-

Geological Survey, Sacramento, C.A. Water Resources Div. T. J. Suk, K. Sorenson, and P. D. Dileanis. Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 86-404, 1986. 1 p, 1 fig, 1 tab.

Descriptors: \*Water quality, \*Parasites, \*Sampling, \*Giardia, \*Maps, Protozoa, Sierra Nevada, California.

During 1984, 60 stream sites were sampled for the presence of Giardia sp. cysts. The sampling sites ranged in elevation from 6,000 to 12,000 feet, and were distributed over a distance of more than 200 miles, from the Lake Tahoe basin in the north to Mt. Whitney in the south. Cysts of Giardia were detected in 27 of 78 samples. The number of cysts detected ranged from 1 to 41. Of the 27 samples positive for Giardia, only 1 cyst was detected in each of 10 samples, 2 cysts were detected in each of 8 samples, 3 cysts were detected in each of 2 samples, 4 cysts were detected in each of 2 samples, 4 cysts were detected in each of 2 samples, 4 cysts were detected in each of 2 samples, and 5, 6, 14, and 41 cysts were detected in 1 sample each. (USGS)

ARSENIC, NITRATE, IRON, AND HARDNESS IN GROUND WATER, GOLDSTREAM ROAD, YANKOVICH ROAD, AND MURPHY DOME ROAD AREAS, (T.1N., R.2W., FM) FAIRBANKS,

Geological Survey, Fairbanks, AK. Water Re-

Geological Survey, Fairbanks, A.K. Walter Resources Div.
G. C. Hopkins, and K. F. Maxwell.
Available from USGS, OFSS, Box 25425, Denver,
CO 80225. USGS Open File Report (map) 85-341,
1985. 1 sheet (map), 2 fig, 1 tab, 13 ref.

Descriptors: \*Arsenic, \*Nitrate, \*Groundwater, \*Alaska, \*Maps, Iron, Hardness, Water wells, Water quality, Fairbanks.

Arsenic, nitrate, iron, and hardness in well water are concerns of homeowners and planners in the Fairbanks North Star Borough, Alaska. Arsenic and nitrate in water may affect human health. Iron and hardness can be aesthetically objectionable, impair plumbing systems, and discolor plumbing fixtures. This report is a compilation of the arsenic, nitrate, iron, and hardness data collected through February 1983 in the Goldstream Road, Murphy Dome Road, and Yankovich-Miller Hill Road areas of Fairbanks. Within these areas, concentrations of arsenic ranged from 0 to 1600 micrograms per liter, nitrate (as nitrogen) ranged from 0 to 78 tions of arsenic ranged from 0 to 1600 mercograms per liter, nitrate (as nitrogen) ranged from 0 to 78 milligrams per liter, iron ranged from 0 to 46 milligrams per liter, and hardness (as calcium carbonate) ranged from 34 to 1220 milligrams per liter. (USGS)
W87-09834

PHYSICAL AND CHEMICAL DATA FOR THE PHYSICAL AND CHEMICAL DATA FOR THE SACRAMENTO RIVER AT RIO VISTA, CALI-FORNIA, NOVEMBER 1983 THROUGH NO-VEMBER 1984, Geological Survey, Menlo Park, CA. Water Re-

e Div

sources Div. A. Y. Ota, L. E. Schemel, S. W. Hager, and D. D. Harmon. Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 86-229, 1986. 33 p, 4 fig, 4 tab, 15 ref.

Descriptors: \*Water quality, \*Sacramento River, \*California, River flow, Specific conductance, Alkalinity, Suspended particulate matter, Dissolved inorganic nutrients, Rio Vista.

Physical and chemical data for the Sacramento River at Rio Vista, California, for the period of November 1983 through November 1984 are pre-sented in this report. Measurements include specif-ic conductance, alkalinity, suspended particulate matter, and the dissolved inorganic nutrients: ni-trite aited and the control of the control trite, nitrate + nitrite, ammonium, dissolved silica, and ortho-phosphate. Numerical results are tabulated and details of the methods are described.

DESIGN, OPERATION, AND MONITORING CAPABILITY OF AN EXPERIMENTAL ARTI-FICLAL-RECHARGE FACILITY AT EAST MEADOW, LONG ISLAND, NEW YORK, Geological Survey, Syosset, NY. Water Resources Div. For primary bibliographic entry see Field 5D. W87-09851

ESTIMATING IRON AND ALUMINUM CONTENT OF ACID MINE DISCHARGE BY USE OF ACIDITY TITRATION CURVES, Geological Survey, Harrisburg, PA. Water Re-

For primary bibliographic entry see Field 7B. W87-09854

EFFECTS OF SURFACE MINING ON STREAMFLOW, SUSPENDED-SEDIMENT, AND WATER QUALITY IN THE STONY FOR PARAMAGE BASIN, FAYETTE COUNTY, PENNSYLVANIA, PINTENNSYLVANIA, PROPERTY OF THE PROPERTY OF THE PROPERTY OF THE PROPERTY OF T Geological Survey, Pittsburgh, PA. Water Re-

s Div.

sources Div.

D. E. Stump, and T. M. Mastrilli.

Available from USGS, OFSS, Box 25425, Denver,
CO 80225. USGS Water-Resources Investigations

Report 84-4362, 1985. 28 p, 17 fig. 13 tab, 16 ref.

Descriptors: \*Water pollution sources, \*Coal mining effects, \*Water quality, \*Streamflow, \*Sus-

#### Sources Of Pollution-Group 5B

pended sediments, \*Pennsylvania, \*Coal mines, Runoff, Erosion, Chemical properties, Contours, Fayette County, Overburden.

A study of the Stony Fork basin in southern Fayette County, Pennsylvania, from 1977 through 1980 determined the impacts of surface coal mining on surface-water quality. Stony Fork was sampled at six sites, during which time the area of surface mines increased from 0.5 to 5.5 percent of the study area. Streamflow, suspended-sediment, and water quality data were collected at gaging stations upstream and downstream of mining. The total runoff between the upstream and downstream stations differed by one percent; this small difference could not be attributed to the effects of mining. The suspended-sediment yield increased during storms due to erosion from the mining sites. The suspended-sediment yield doubled at the downstream site following mining. Specific conductance was highly variable during storm runoff but generally varied inversely with flow and increased slightly during the study period. The plarned between 4.8 and 7.9 with values below 6.0 usually occurring during storm runoff. Concentrations of dissolved zine and sulfate increased between the upstream and downstream sampling sites. Laboratory analysis of a precipitation sample indicates that acid precipitation may be partly responsible for pH depressions during storm runoff periods. (USGS)

ASSESSMENT OF LOW-FLOW WATER QUALITY IN THE DU PAGE RIVER, ILLINOIS, Geological Survey, Urbana, IL. Water Resources

DIV.
W. O. Freeman, A. R. Schmidt, and J. K. Stamer.
Available from USGS, OFSS, Box 25425, Denver,
CO 80225. USGS Water-Resources Investigations
Report 85-4344, 1986. 98 p. 28 fig. 13 tab, 35 ref.

Descriptors: \*Low flow, \*Water quality, \*Water-assimilative capacity, \*Dissolved oxygen, \*Computer models, \*Water quality standards, \*Illinois.

The relations of several stream processes to concentrations of dissolved oxygen and other constituents during low-flow periods were evaluated for a 70.3-mile reach of the Du Page River in northeast-ern Illinois, using measured data and computer simulations. Reaeration rates and traveltimes were measured at various flow rates using a steady-state gas-tracer technique. Stream discharge, stage, temperature, and chemical constituent concentrations were measured during two 24-hour periods in July and August 1983. These data were used to describe water quality and to calibrate and verify the QUAL-II one dimensional, steady-state, water quality model. Dissolved oxygen concentrations did not meet the State water quality standards in several subreaches of the Du Page River. Concentrations were consistently below the State minimum dissolved oxygen standard in the downstream 8 miles of the East Branch Du Page River. Model simulations indicate that although ammonia oxidativa attoast declarity and the state of the state of the state of the state of the distinct of the state of the simulations indicate that although ammonia oxida-tion played a role in the dissolved oxygen depletion, the primary factor was sediment oxygen demand. Other measured chemical constituents that did not comply with the State water quality standards in several subreaches of the river included ammonia, iron, fluoride, and total dissolved solids. (USGS)

QUALITY OF WATER IN THE PRINCIPAL AQUIFERS OF SOUTHWESTERN WASHINGTON, Geological Survey, Tacoma, WA. Water Re-

Geological Survey, Tacoma, WA. Water Resources Div.
J. C. Ebbert, and K. L. Payne.
Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 84-4093, 1985. 59 p, 2 fig, 5 plates, 19 tab, 20 ref.

Descriptors: \*Water quality, \*Groundwater, \*Washington, Water quality standards, Aquifers, Nitrates, Iron, Manganese.

The quality of water in major aquifers in south-western Washington was addressed in terms of

inorganic-constituent, trace-metal, and fecal-coliform concentrations. Results of this assessment in-dicate that the groundwater in southwestern Washington can be characterized as soft to moderately hard with a low concentration of dissolved solids. hard with a low concentration of dissolved solids. Nitrate was the only constituent found at concentrations above maximum contaminant levels specified by the U.S. Environmental Protection Agency primary drinking water regulations. The most prevalent detriment to the otherwise good quality of groundwater in the region was concentrations of iron and manganese that exceeds limits recommended by the U.S. Environmental Protection Agency secondary standards. Although these limits were exceeded in less than one half of the samples, high concentrations of iron and manganese. samples, high concentrations of iron and manga-nese were common throughout the entire region. (USGS) W87-09862

EFFECTS OF POTENTIAL SURFACE COAL MINING ON DISSOLVED SOLIDS IN OTTER CREEK AND IN THE OTTER CREEK ALLUVIAL AQUIFER, SOUTHEASTERN MONTANA, Geological Survey, Helena, MT. Water Resources

For primary bibliographic entry see Field 4C. W87-09864

SEEPAGE CHARACTERISTICS THROUGH AN ABANDONED TAILINGS PILE,

ABANDONED I ALLINGS FILE, Idaho Univ., Moscow. A. G. Morilla, and D. H. Fortier. IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volume II, 1984. SIAMOS 78. p 847-862, 12 fig, 6

Descriptors: \*Water pollution sources, \*Path of Descriptors: "Water pollution sources, "Path of pollutants, "Mine wastes, "Groundwater pollution, "Groundwater, o"Mathematical models, Model studies, Water pollution, Industrial wastes, Idaho, Seepage, Seepage control, Leaching, Precipitation, Geohydrology, Groundwater hydrology, Groundwater movement, Finite element method, Mathematical studies, Lagoons, Groundwater level,

Twelve tailings piles have been installed in the Coeur d'Alene Mining District in northern Idaho since 1968. Several of these ponds were recently filled and abandoned. The abandonment of mine nlied and abandoned. The abandonment of mine tailings piles may have detrimental effects on the water resource system in the immediate area by leaching of precipitation through the pile material. A study was conducted to determine the hydro-geological factors that control the movement of geological factors that control the movement of groundwater through the abandoned Page tailings pile in this area. A data collection network was designed to collect data on groundwater potential and quality. Analysis of the water level data showed the existence of a groundwater mound under a portion of the tailings pile. The flow system in the pile responds both to precipitation and to periods of no recharge. A finite element steady-state mathematical model was constructed to analyze the groundwater flow system in the stady-state mathematical model was constructed to analyze the groundwater flow system in the Page pile. A sampling and testing program of the pile provided information on values of hydraulic conductivity. This data was incorporated as input to the mathematical model. Operation of the model showed that the location and fluctuations of the regional groundwater table and the quantity of recharge to the tailings pile from precipitation were the primary controlling factors for the location and height of the groundwater mound. A sewage lagoon system was installed on the abandoned pile after the beginning of the study. A previous study reported on the water level increases resulting from the construction and filling of the lagoons. Output data from the operation of the model, with the sewage lagoons, showed a similar rise in the water level and a maximum potential leakage of seven percent of inflows. (See also W87-09568) (Author's abstract)

UNDERGROUND MINE DRAINAGE QUANTI-TY AND QUALITY GENERATION MODEL, Ohio State Univ., Columbus. Dept. of Civil Engi-

V. Ricca, and M. Hemmerich. In: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volume II, 1984. SIAMOS 78. p 863-882, 7 fig. 3

Descriptors: \*Mine drainage, \*Water pollution sources, \*Path of pollutants, \*Acid mine drainage, \*Groundwater pollution, \*Groundwater, \*Model studies, \*Simulation, \*Data interpretation, Fate of pollutants, Coal mines, Mathematical models, Computer models, Hydrologic models, West Virginia. ginia

This computer model is capable of simulating un-derground mine makewater and its consequent dis-charge rate from adits. An additional feature is its ability to generate acid loads associated with the drainage. A hydrogeologic model using climato-logical data, watershed parameters, and mine oper-ation information is used to calculate the amount of water passing to the geologic strata of the mine. As the water movement through the mine works is modeled, the acid generated is simulated by mathe-matical formulations describing the chemical pro-ductions and removal mechanisms. The component contributions are summed, with time preservation, and expressed as discharge rates and loads. The model is presented as a case study application to a model is presented as a case study application to a coal mine in West Virginia, USA. (See also W87-09568) (Author's abstract)

INFLUENCE OF POTASSIUM MINING IN CA-TALONIA ON THE QUALITY OF THE WATER OF THE LLOBREGAT RIVER (BARCELONA) (INFLUENCIA DE LA MINERIA POTASICA CATALANA EN LA CALIDAD DEL AGUA DEL RIO LLOBREGAT (BARCELONA)),

Comisaria de Aguas del Pirineo Oriental, Barcelo-na (Spain).

E. Diaz, E. Custodio, and A. Galofre.

In: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volume II, 1984. SIAMOS 78. p 989-1011, 8 fig, 12

Descriptors: "Water pollution sources, "Path of pollutants, "Fate of pollutants, "Water quality, water quality, control, "Mine wastes, "Rivers, Industrial wastes, Potash, Pollutants, Minerals, Llobregat River, Spain, Dissolved solids, Salinity, Saline water, Downstream, Surface water, Salts,

The exploitation of potash minerals in the central Llobregat River basin results in the discharge of very saline water which noticeably increases the total dissolved solids content of the surface waters total dissolved solids content of the surface waters downstream. The discharge reaches and sometimes surpasses 5 kg/s NaCl in a river in which the mean flow near the mouth is about 20 cu m/s. The discharged salt originates in the mineral treatment facilities in the tips leachate, in the relief modification of the saline outcrops and the mine drainage. The origin and trend of the discharges in the different localities and the successive improvements are studied and the clear influence on the groundwater salinity is noted. Some possible solu-tions are introduced. (See also W87-09568) (Author's abstract)

WATER IN THE MINING OF SOFT COAL. A STUDY OF A PILOT AREA (EL AGUA EN LA MINERIA DE LA HULLA, ESTUDIO DE UNA

ZONA PILOTO), Empresa Nacional Adaro de Investigaciones Mineras S.A., Madrid (Spain).

eras 3-A., mauria (opani). R. Fernandez Aller. IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volume II, 1984. SIAMOS 78. p 1013-1025, 3 tab.

Descriptors: \*Water pollution sources, \*Pollutants, Descriptors: "water poliution sources, "Foliutains, "Water management, "Mine drainage, "Mine wastes, "Coal mining, "Rivers, Alkaline mine drainage, Drainage water, Industrial wastes, Coal, Pollution load.

#### Group 5B-Sources Of Pollution

A summary of the study conducted in 1973 of water management in the Asturias coal basin in northern Spain affecting the Nalon River is presented. The problems of water drainage and waste water generated by coal preparation plants operating at the time of the study were mentioned. The most important pollutant load was found to be generated in the coal preparation plants. Because the drainage waters are alkaline, the pollution of the river is not serious although the large volume. the river is not serious although the large volume of the wastes should be considered. (See also W87-09568) (Wood-PTT)

CONTROL AND TREATMENT OF RESIDUAL WATER IN MINING (CONTROL Y TRATA-MIENTO DE AGUAS RESIDUALES EN MIN-ERIA),

Empresa Nacional Adaro de Investigaciones Mineras S.A., Madrid (Spain).

eras 5.A., Mauriu (spain). R. Fernandez Aller. IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volume II, 1984. SIAMOS 78. p 1027-1048, 5 fig, 4 tab. 19 ref.

Descriptors: \*Water pollution sources, \*Wastewater treatment, \*Mine wastes, \*Mine drainage, \*Oxidation process, \*Wastewater oxidation, \*Neutralization, \*Desalination, \*Aeration, Demineralization, Industrial wastes, Hydrogen ion concentration, Acid mine drainage.

Wastewaters from mining activities are important pollutants, especially those which have a low pH because most of the metals are solubilized. The problem of mine waste water is solved in two different ways: (1) by reducing a solved in two ifferent ways: (1) by reducing the infiltration of the waste waters by using control systems as part of mining techniques, and (2) by wastewater treat-ment including oxidation or evaporation ponds, neutralization, desalination, and aeration processes. (See also W87-09568) (Author's abstract)

SULFATE CONTENT OF THE WATERS STORED IN THE IRON ORE MINES OF LOR-RAINE (FRANCE) (TENEUR EN SULFATES DES EAUX STOCKEES DANS LES MINES FER DE LORRAINE (FRANCE), Ecole Nationale Superieure de Geologie Appliquee et de Prospection Miniere, Nancy (France). D. Herve.

In: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol-umes I and II, 1984. SIAMOS 78. p 1063-1079, 10 fig. 10 tab, 5 ref.

Descriptors: \*Water pollution sources, \*Mine drainage, \*Mine wastes, \*Iron mining, \*Sulfate, Heavy metals, Iron, France, Calcium sulfate, Calcium compounds, Pyrite, Weathering.

Iron mining waters of Lorraine (France), especially in former drowned mines, show an inconvenient amount of calcium sulfate. The origin of this mineralization, which may reach 800 mg/l in SO4, was sought by observing it in situ, by analyzing its isotopes, and by systematically leaching the rocks. The results show that the sulfates come from the weathering of pyrite which is spread in the top of the ore bed. The weathering starts again whenever the level of the water changes. Accumulating in-formation is necessary for mathematical modeling of chemical exchanges between water and rock (Author's abstract) W87-09890

TEMPERATURE REGIME IN THE SAVA R. ALUVION NEAR ZAGREB,
Zagreb Univ. (Yugoslavia). Faculty of Geodesy.

Zagres Only. (Tugosiavia). Faculty of Geodesy. R. Sarnavka. IN: Water in Mineria y Trabajos Subterraneos), Vol-umes 1 and II, 1984. SIAMOS 78. p 1331-1549, 4 fig. 18 ref.

Descriptors: \*Groundwater pollution, \*Thermal pollution, \*Water pollution sources, \*Path of pollutants, \*Water quality, Water pollution, Sava

River, Zagreb, Yugoslavia, Alluvial reservoirs, Municipal water, Mathematical equations, Hydro-geology, Hydrologic aspects.

The quality of the groundwater used for the Zagreb water supply and the temperature regime of territorial waters was investigated in order to prevent eventual thermal contamination by the highgrade pollution in the Sava River which replenishes the alluvial reservoir. The results obtained prove the immediate relation between the temperature of the Sava River and the groundwater and explain certain relevant characteristics. The er and explain certain relevant characteristics. The temperature interrelation also indirectly verified the hydrogeological assumptions of the continuity of the water-bearing stratum. The expected time shift is determined; the maximal temperatures of the groundwater fall behind the maximal temperature of the Sava River by between 61 and 81 days while the minimal temperatures differ by between 40 and 60 days depending on the zone studied. (Wood-PTT) W87-09908

MARINE POLLUTION AND COUNTERMEAS-URES IN JAPAN,

Environment Agency, Tokyo (Japan). Water Qual-

Oceans, Vol. 30, No. 1, p 55-60, Spring 1987. 5 fig,

Descriptors: \*Water quality, \*Water quality management, \*Water quality standards, \*Monitoring, \*Water pollution, \*Chemical oxygen demand, Japan, Water pollution control, Standards, Environment, Economic growth, Fisheries, Effluents,

Water pollution increased in the sea around Japan during the country's rapid economic growth in the 1960s and 1970s causing damage to coastal fisheries and beaches. Governmental monitoring of the seawater quality was instituted; water samples were tested for a variety of chemical compounds, pH, chemical oxygen demand (COD), suspended solids, and other indicators of pollution. COD was determined to be the most important. Average COD values were given for the main bays and COD values were given for the main bays and ports of Japan. National standards intended to protect human health and the living environment were determined and effluent controls were imposed on all factories and commercial establishments in Japan. 81% of all sea areas in Japan meet the standards set although the achievement rates are lower in Tokyo Bay, Ise Bay, Seto Inland Sea and Osaka Bay. As a result of effluent control, areawide total pollutant load control, and extension of the sewer system to include a greater percentage of the population, sea pollution by Japan is no longer critical. Further efforts are required to boost the quality standard achievement ratio and to eliminate the red tide cases in the Seto Inland Sea. (Wood-PTT) W87-09932

DIURNAL PATTERNS OF AMMONIUM LOADING AND LOSS IN A STREAM RECEIVING SECONDARY TREATMENT EFFLUENT, Iowa State Univ., Ames. Dept. of Botany. W. G. Crumpton, and C. M. Hersh. Journal of the Water Pollution Control Federation JWPFAS, Vol. 59, No. 1, p 60-62, January 1987. 2 fig, 9 ref. DOI Project G-906-05.

Descriptors: \*Diurnal distribution, \*Ammonium, "Secondary wastewater, "Efflients, "Streams, "Water pollution effects, Distribution, Wastewater reatment, Nitrogen, Chemical analysis, Nitrates, Sampling, Path of pollutants, Fate of pollutants.

Diurnal patterns of ammonium loading from a Diurnal patteris of ammonium loading from a secondary wastewater treatment facility and diurnal patterns of in-stream ammonium loss were determined in the South Skunk River near Ames, Iowa. Three diel studies were conducted during periods of low flow in the fall of 1984. Ammonium and nitreal nitrogen were measured union an autoand nitrate nitrogen were measured using an auto-mated procedure described by Mertens et al., except that flow injection rather than air segmentation of the sample stream was used. A pronounced

diurnal pattern was found in effluent ammon concentrations which rose sharply near noon each day and declined to lowest levels by the following morning. Very similar patterns were found in efflu-ent discharge rates. Nitrate loads from the Ames treatment plant were also consistently high and greatly increased the nitrate concentrations in the river. Problems in the analytical procedure for nitrate measurement made patterns for the latter two sampling periods difficult to interpret. Ammonium losses were not reflected by concomitant nitrate increases, indicating that losses were the result of removal. Data indicate the significance of diurnal patterns in ammonium loading and loss in affected streams. (Doria-PTT)

REMOTE SENSING OF COASTAL POLLUT-ANTS USING MULTISPECTRAL DATA, Delaware Univ., Newark. Coll. of Marine Studies. For primary bibliographic entry see Field 7B. W87-10023

AEROSPACE REMOTE SENSING OF THE COASTAL ZONE FOR WATER QUALITY AND BIOTIC PRODUCTIVITY APPLICATIONS, National Aeronautics and Space Administration, Hampton, VA. Langley Research Center. For primary bibliographic entry see Field 7B. W87-10024

SATELLITE DETECTION OF OIL ON THE MARINE SURFACE, National Aeronautics and Space Administration, Washington, DC. For primary bibliographic entry see Field 7B. W87-10029

APPLICATION OF LANDSAT AND COMPUT-ER TECHNOLOGY TO POTENTIAL WATER POLLUTION FROM SOIL EROSION,

National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.

W. J. Campbell.

IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 616-621, 4 fig, 1 tab, 5 ref.

Descriptors: \*LANDSAT, \*Computers, \*Water pollution sources, \*Soil erosion, \*Hydrology, \*Sat-ellite technology, \*Remote sensing, Nonpoint pol-lution sources, Case studies, Water quality, Cost analysis. Spectral analysis.

Agricultural activity has been recognized as the Agricultural activity has been recognized as the primary source of nonpoint source water pollution. Water quality planners have needed information that is timely, accurate, easily reproducible, and relatively inexpensive to utilize to implement 'Best Management Practices' for water quality. In this paper, a case study shows how the combination of paper, a case study shows how the combination of satellite data, which can give accurate land-cover/ ation of satellite data, which can give accurate anti-cover) land-use information, and a computerized geo-graphic information system, can assess nonpoint pollution at a regional scale and be cost effective. Since this study just begins to explore the poten-tially significant resource and environmental information that can be extracted from Landsat MSS data. DAta from the Landsat program are readily available and can be extended to many different available and can be extended to many different categories of environment and resource manager's problems. To minimize the technical barriers to Landsat-IMGRID interfacing, the author believes that: (1) Imagery products should be made available to users fully processed (radiometrically and geometrically corrected) to correspond to USGS 7-1/2 minute topographic quadrangles. This will allow 'nontechnical' personnel such as a planner, to orient classified satellite data to more easily expensive and universally used data such as the to orient classified satellite data to more easily recognized and universally used data such as the USGS sheets; (2) A 'pipeline' type of system or a brouse facility in every state should be initiated so that users can obtain satellite data with specific information such as amounts and location f cloud cover in a given satellite scene. This would eliminate purchases of redundant or unwanted informanate purchases of redundant or unwanted informa-tion; (3) Turnaround time should be decreased to permit more rapid and economical processing of

#### Effects Of Pollution-Group 5C

remote sensor data for 208-type planning. The value of satellite data is recognized only when the information is in the hands of the user; and (4) Future Landsat series satellites should provide a greater resolution size that could be used to differentiate, and perhaps identify rock and soil types, topography and other hydrologic data that are influenced in traditional and other 208 categories. This information will enhance the traditional hand collected data and eventually augment or end the time spent and appreciably reduce the cost of hand collected data. (Lantz-PTT) W87-10031

BAY OF FUNDY VERIFICATION OF A SYSTEM FOR MULTIDATE LANDSAT MEAS-UREMENT OF SUSPENDED SEDIMENT, Virginia Inst. of Marine Science, Gloucester Point. For primary bibliographic entry see Field 7B. W87-10032

APPLICATION OF DIGITAL IMAGE PROCESSING TECHNIQUES AND INFORMATION SYSTEMS TO WATER QUALITY MONITOR-ING OF LAKE TAHOE,
Jet Propulsion Lab., Pasadena, CA.
For primary bibliographic entry see Field 7B.
W87-10036

STUDIES OF UPTAKE AND TOXIC EFFECTS OF CR(VI) ON PISTIA STRATIOTES, Visva-Bharati Univ., Santiniketan (India). Dept. of

Chemistry.

A. K. Sen, N. G. Mondal, and S. Mandal.

Water Science and Technology WSTED4, Vol.

19, No. 1/2, p 119-127, 1987. 2 fig, 6 tab, 26 ref.

Descriptors: \*Wastewater treatment, \*Pistia, \*Bioaccumulation, \*Path of pollutants, \*Chromium, \*Water pollution effects, Cultures, Enzymes, Heavy metals.

The uptake of Cr(VI) and toxic effects of the metal on some biochemical parameters in Pistia stratiotes
L. were studied. The uptake of Cr(VI) by the
plants gradually increased with increase in concentration of Cr(VI) in the culture medium. Maximum tration of Cr(VI) in the culture inculum:

accumulation of Cr(VI) was noted within 5 days.

Maximum removal (about 90%) of Cr(VI) was
recorded below 5 ppm. Accumulation of Cr(VI)
occurred mainly in roots. At 5 and 10 ppm, Cr(VI) occurred mainly in roots. At 5 and 10 ppm, Cr(VI) promoted senescence of Pistia plants by decreasing chlorophylls, protein, RNA, Hill activity and activities of catalase, protease as well as increasing dry weight, free amino acid content, peroxidase activity and ratio of acid to alkaline pyrophosphase activity over control values. At Cr(VI) concentrations below 5 ppm, these constituents were least affected. So, Pistia plants can be utilized as the scavenger of Cr(VI) from waste water. (Author's abstract)

EFFECTS OF SELENIUM ON THE DISTRIBUTION OF MERCURY IN THE ORGANS OF THE BLACK BULLHEAD (ICTALURUS

MELASI, South Dakota Univ., Vermillion. Dept. of Biology. For primary bibliographic entry see Field 5C. W87-10079

RECURSIVE WATER QUALITY FORECAST-ING MODELS FOR URBAN CATCHMENTS, For primary bibliographic entry see Field 7C. W87-10108

#### 5C. Effects Of Pollution

HEALTH HAZARDS FROM NITRATES IN DRINKING-WATER. World Health Organization, Copenhagen (Den-mark). Regional Office for Europe. Report on a WHO Meeting, Copenhagen, Den-mark, 5-9 March 1984, 1985. 102 p.

Descriptors: \*Nitrates, \*Drinking water, \*Water pollution effects. Potable water. Hazards, Public

health, Groundwater quality, Fertilizers, Water supplies, Water pollution prevention, Water treat-ment, Standards.

While in many regions of the work, the main problem concerning drinking water is to obtain adequate supplies, in Europe the main problems are due to chemical contamination. Increased application of artificial nitrogenous fertilizers, growing problems with animal waste disposal, changes in land use, and increasing concentration of nitrogen oxides in precipitation have resulted in marked increased in nitrate levels in drinking water in some areas. Although WHO's drinking water standards have been reviewed as recently as 1980, ards have been reviewed as recently as 1980, standards have been reviewed as recently as 1980, the situation with respect to nitrate needed to be reexamined. A Working Group on Health Hazards from Nitrates in Drinking Water was convened in Copenhagen, March 5-9, 1984, by the WHO Regional Office for Europe. It brought together 14 experts from 9 countries and a representative of the International Program on Chemical Safety. This book presents the material discussed at this workshop, and concludes that: (1) The use of different units to express nitrate levels in various media, including water, is unsatisfactory and uniformity is including water, is unsatisfactory and uniformity is needed; (2) Levels of nitrate in water sources used needed; (2) Levels of nitrate in water sources used for drinking water supply are increasing, especially the levels in groundwater supplies; (3) Increasing use of artificial fertilizers, disposal of waste (par-ticularly from animal farming) and changes in land use are the main factors responsible for the pro-gressive increase of nitrate levels in water supplies; (4) For most people in Europe, drinking water contributes no more than 30% of the total dietary nicontributes no more than 30% or the total clearly nitrate of nitrates. The main source of dietary nitrate is vegetables; (5) Drinking water with a nitrate concentration at or lower than the present WHO guideline value of 10 mg/L of NO3-N is of satisfactory quality for bottle-fed infants; (6) There is no convincing evidence of a relationship besatisfactory quality for bottle-fed infants; (6) There is no convincing evidence of a relationship between gastric cancer and consumption of drinking water containing nitrates at or below the present guideline value. Above this level, the evidence is inconclusive; and (7) Satisfactory nitrate removal. from drinking water will present serious technical and financial problems to water undertakings. (Lantz-PTT)

ACID RAIN AND DRY DEPOSITION. Oklahoma Univ., Norman. Environmental and Ground Water Inst. For primary bibliographic entry see Field 5B. W87-09624

EFFECTS OF SEWAGE OUTFALLS ON INTER-TIDAL ECOSYSTEMS IN KUWAIT, Kuwait Inst. for Scientific Research, Safat. Dept. of Environmental Sciences. P. Literathy, L. N. Ali, M. A. Zarba, and K. Water Science and Technology WSTED4, Vol. 18, No. 11, p 35-45, 1986. 4 fig, 3 tab, 17 ref.

Descriptors: \*Water pollution effects, \*Wastewater disposal, \*Outfall, \*Waste disposal, \*Wastewater, Coastal waters, Effluents, Nutrients, Kuwait, Tidal effects, Sediments.

Kuwait City has an impact on the nearshore marine environment by discharging sewage ran-domly through short emergency outfalls into the intertidal zone. The effect of the discharged sewage on the biological activity and the chemical characteristics of the relevant intertidal areas, which are controlled by a dry, tropical climate, was studied. Pore water, tidal water characteristics was studied. Pore water, tidal water characteristics and nutrient release and transport from the intertical zone during tidal flushing were investigated in polluted and unpolluted areas. The accumulation of particulate organic matter in the upper, middle and lower intertidal zones was characterized. It was concluded that in addition to settling, a great deal; of particulate organic matter entered into the upper tidal sediment by infiltration during high tide and was filtered out by the sediment and migrated toward the low tide zone during the falling tide. The rate of the release of the substances associated with inorganic particulates was controlled by the overall organic load and the

microbial activity. Sediment core samples were taken for multistage carbon dioxide treatment, and the results showed a decrease in carbonate-bound the results showed a decrease in carbonate-bound phosphates with depth. Photosynthetic productivity observed during the spring showed a close relationship with the sewage discharges and were also controlled by the limiting nutrient for photosynthesis was nitrogen rather than phosphorous. The release of some heavy metals from the sewage-polluted intertidal sediment was significant, and beachrock development also related to the discharges. The intertidal fauna was improverished because of the organic sludge. (Author's abstract) abstract) W87-09636

ASSOCIATION BETWEEN MORBIDITY AMONG BATHERS AND MICROBIAL QUAL-ITY OF SEAWATER, Hadassah Medical School, Jerusalem (Israel). En-

vironmental Health Lab. attal, E. Peleg-Olevsky, Y. Yoshpe-Purer, and H. I. Shuval.

Water Science and Technology WSTED4, Vol. 18, No. 11, p 59-69, 1986. 2 fig, 7 tab, 23 ref.

Descriptors: \*Water pollution effects, \*Recreation, \*Swimming, \*Wastewater disposal, \*Outfall, \*Waste disposal, \*Outfall, \*Wastewater, Coastal waters, Effluents, Israel, Surveys, Bacteria, Coliforms.

During the summer of 1983, a prospective epidemi-During the summer of 1983, a prospective epidemi-ological study was carried out at three coastal beaches in the area of Tel-Aviv, Israel, in order to investigate the effect of marine pollution on mor-bidity among bathers. A total of 615 families com-prising 2,231 persons, 23% of them aged 0-4 years, were interviewed for this study. A total of 78 seawater samples were laboratory tested on the day of collection for the concentration of six bacte-rial indicators: fecal coliforms, fecal streptococci, E. coli. Staphylococcus aureus and Pseudomonas rial indicators: fecal coliforms, fecal streptococci, E. coli, Staphylococcus aureus and Pseudomonas aeruginosa. The geometric mean of the fecal coliforms was the highest at all beaches, and the concentration of pseudomonas the lowest. All beaches complied with Israel Ministry of Health, bacterial standards for bathing beaches and were within the WHO/UNEP guidelines for fecal coliforms. However, analysis of the results indicated that symptoms of enteric morbidity among swimmers, particularly in the 0-4 year old age group, were related to 'high' density levels of enterococi, E. coli and staphylococci. Also, swimmers had more morbidity symptoms of all types ('enteric', 'respiratory' and 'others') than nonswimmers, regardless of the microbial quality of seawater. (Author's abstract)

EFFECT OF SEWAGE SLUDGE DISPOSAL TO SEA THROUGH PIPELINES PREVIOUSLY DISCHARGING ONLY SETTLED EFFLUENT, Water Research Commission, Pretoria (South

Arncas.
J. E. McGlashan, and D. C. Macleod.
Water Science and Technology WSTED4, Vol.
18, No. 11, p 93-104, 1986. 3 fig, 8 tab, 20 ref.

Descriptors: \*Water pollution effects, \*Wastewater disposal, \*Outfall, \*Waste disposal, \*Wastewater, Coastal waters, Effluents, Settling, South Africa, Design criteria.

The City of Durban has two submarine outfall sewers designed for the disposal of approximately 365 000 cu m/d of domestic and industrial effuents. Until recently these outfall sewers were only permitted to discharge settled effluents, the resultant sludge having to be treated and disposed of on land in the one instance and incinerated in the other. As the result of a two year program of research the city has been permitted to discharge settled effluent from both outfalls to which the underflow from the sedimentation basins has been settled effluent from both outfalls to which the underflow from the sedimentation basins has been reintroduced. Retention of the sedimentation basins has permitted effective removal of floatable material. The pipelines were operated during the research period by discharging only settled effluent from the one whilst from the other the discharge consisted of the settled effluent stream to which the sludge had been reintroduced. Halfway

#### Group 5C-Effects Of Pollution

through the program the roles of the two pipelines were reversed. This paper briefly reviews marine disposal in South Africa, the Durban submarine outfalls, the events which preceded the research project, the design of the research program and the results of the study in terms of bacteriological, biological and chemical monitoring, current measurements in the immediate vicinity of the pipelines and dilution calculations with the aid of more rigorous mathematical treatment. (Author's abstract)

SOME BASIC CONSIDERATIONS FOR MARINE DISPOSAL OF WASTEWATER AND

SOLID WASTES, Setsunan Univ., Neyagawa (Japan). For primary bibliographic entry see Field 5E. W87-09651

POLYCYCLIC AROMATIC HYDROCARBON IN VITRO CYTOTOXICITY TO BLUEGILL BF-2 CELLS: MEDIATION BY S-9 MICROSOMAL FRACTION AND TEMPERATURE, Rockefeller Univ., New York. Lab. Animal Re-

Descriptors: \*Water pollution effects, \*Cytotoxicity, \*Polycyclic aromatic hydrocarbons, \*Bluegill, Incubation, Organic compounds, Fish physiology, Sunfish, Fish.

The in vitro cytotoxicities of various polycyclic aromatic hydrocarbons (PAHs) to bluegill sunfish BF-2 cells were determined with the neutral red assay, which was modified by the incorporation of an S-9 microsomal fraction. Whereas the PAHs per se were weakly cytotoxic, the presence of the S-9 fraction in the incubation mixture increased the cytotoxicity of many of the PAHs (whether in the absence or presence of the S-9 microsomal fraction) was potentiated if the 6 h exposure was at 37, rather than at 26 C. (Author's abstract) W87-09654

TOXICTIES OF SOME HEAVY METALS TO THE TADPOLES OF FROG, MICROHYLA ORNATA (DUMERIL AND BIBRON),

Mangalore Univ. (India). Dept. of Biosciences.
J. Rao, and M. N. Madhyastha.
Toxicology Letters TOLED5, Vol. 36, No. 2, p
205-208, April 1987. 1 tab, 15 ref.

Descriptors: \*Water pollution effects, \*Bioassay, \*Frogs, \*Tadpoles, \*Heavy metals, \*Toxicity, Sensitivity, Mercury, Cadmium, Copper, Manganese,

Static bioassays were conducted to determine the relative acute toxicities of five heavy metals (mer relative acute toxicities of five heavy metals (mercury, cadmium, copper, manganese and zinc) to 1-week-old and 4-week-old tadpoles of the frog, Microhyla ornata. Toxic effects were calculated on the basis of LC50 for 24 h, 48 h, 72 h and 96 h exposures at 25.5-26.0 C. Mercury was the most toxic and zinc was the least toxic of the heavy metals tested. The sensitivity of the tadpoles to the heavy metals increased with increased age. (Author's abstract) thor's abstract) W87-09655

EFFECT OF PETROLEUM HYDROCARBONS ON THE MICROBENTHOS OF THE WHITE

State Oceanographic Inst., Moscow (USSR).
V. N. Tkachenko, and I. V. Burkovskii.
Soviet Journal of Ecology SJECAH, Vol. 17, No.
5, p 258-263, September-October 1986. 2 fig. 12 ref.
Translated from Ekologiya, No. 5, p 9-15, September-October 1986

Descriptors: \*Water pollution effects, \*Petroleum hydrocarbons, \*White Sea, \*Littoral zone, Algae, Protozoa, Limnology, Trophic level.

The sandy littoral of the White Sea is a suitable testing ground for field toxicological experiments

with both benthic organisms of different trophic levels and the bottom biocenose as a whole. Low concentrations of petroleum hydrocarbons in bottom deposits can affect the development of benthic communities on the first and second trophic levels. In th course of this, both stimulatory and inhibitory effects are observed in diatoms, while the same concentrations act only as depressors on psammophilic protozoa. The character of the re-sponse of diatoms to the effect of low petroleum-product concentrations in the sediment was nonhomologous even among members of the same genus. Decrease in the number of psammophilic infusoria Decrease in the number of psammophilic infusoria under the effect of petroleum hydrocarbons in the sediment disrupts the trophic connection of the first two levels, which leads to a sharp increase in the quantity of species of diatoms that are protozoan food objects. Colonization of polluted bottom deposits by diatoms and protozoa o.curs slowly and, in the absence of additional pollution, reaches the control level after a year. Petroleum pollution bottom deposits can lead to substantial displacements in the functioning of individual links fo the bottom biocenose, which may result in a subsequent disruption of the ecological balance in the region. (Alexander-PTT) region. (Alexander-PTT) W87-09677

DEPENDENCE OF SUMMER PLANKTON IN-DICES ON CONTENT OF BIOGENIC ELE-MENTS IN SMALL LAKES OF LATGALIA WITH VARYING LEVELS OF ANTHROPO-GENIC EUTROPHICATION.

Akademiya Nauk SSSR, Leningrad. Inst. Ozerovedeniya. I. S. Trifonova, N. V. Ignat'eva, V. V. Maslevtsov,

and T. A. Ostrovskaya. Soviet Journal of Ecology SJECAH, Vol. 17, No. 5, p 278-284, September-October 1986. 2 fig, 2 tab, 15 ref. Translated from Ekologiya, No. 5, p 31-38, September-October 1986.

Descriptors: \*Water pollution effects, \*Eutrophic lakes, \*Plankton, \*Mathematical equations, \*Nutrients, Nitrogen, Phosphorus, Latgalia Upland, Lakes, Limnology.

Using the example of 14 small lakes (< i sq km surface area) in the Latgalia Upland with varying levels of trophicity, summer phyto-, bacterio-, and zooplankton were shown to be linked with the concentration of common forms of nitrogen and phosphorus and their ratio in the water. Regression equations describe the empirical dependences be-tween indices for plankton and content of biogenic elements and show a direct dependence of the trophic level in the lakes on the total phosphorus content in their epilimnion. During the stagnation period, a direct link was observed between all indices of phytoplankton production and total P concentration. At a total N: total P ratio of 10 or below in the lakes studied, there was a direct dependence between the level of phytoplankton dependence between the level of phytoplankton productivity, its biomass, production and concentration of chlorophyll, and total N. High coefficients of correlation for equations describing the dependence of chlorophyll a and intensity of photosynthesis at optimal depth on N and P content indicat that these indices are most appropriate for estimating the trophic status of lakes. (Peters-PTT) W87-09678

MARINE POLLUTION AND HEALTH IN SOUTH AFRICA, Cape Town Univ. (South Africa). Dept. of Zoolo-

gy. A. C. Brown.

South African Medical Journal, Vol. 71, No. 4, p 244-248, February 1987. 4 fig, 46 ref.

Descriptors: \*Water pollution effects, \*South Africa, \*Coastal waters, \*Public health, Waste dis-posal, Bioaccumulation, Food chains. \*South

Although the RSA does not have a serious marine Atthough the KSA does not have a serious marine pollution problem, rapid population growth and increasing industrialisation make it imperative to assess the pollution status of coastal waters and to plan for future developments. All pollution on earth ends up in the sea, which consequently contains a mixture of substances, the effects of which

on the biota and on human health are poorly understood. Many of these substances are accumulated by marine organisms and become ever more concentrated along the food chain; where man is at the top of the chain, he thus runs the greatest risk of all. Too much raw sewage is allowed to pollute the sea, the provision of sewage treatment plants being largely inadequate for the growing popula-tion. Notwithstanding the excellent work done by a number of South African organisations and indi-viduals, and the sound basis of the country's antimarine pollution legislation, a plea is made for greater co-operation between those whose expertise and/or official position would enable them to contribute to combating the problem. (Author's abstract) W87-09679

TEMPERATURE DEPENDENCE OF DI-2-ETH-YLHEXYL PHTHALATE (DEHP) PHARMA-COKINETICS IN RAINBOW TROUT, Washington State Univ., Pullman. Coll. of Phar-

macy.
M. G. Barron, B. D. Tarr, and W. L. Hayton.
Toxicology and Applied Pharmacology TXAPA9,
Vol. 88, No. 3, p 305-312, May 1987. 7 tab, 1 fig, 29
ref. NIEHS Grant ES 01995 and EPA Grant R812818

Descriptors: \*Water pollution effects, \*Isotope studies, \*Phthalates, \*Model \*Temperature effects, Bioaccumulation, tion, Fish, Toxicity, Distribution. studies

Rainbow trout (Salmo gairdneri) acclimated at 6, 12, or 18 C received 400 microgram(ug) (14C)DEHP/kg as an intraaortic bolus DEHP disappeared rapidly from plasma, with an estimated 50% of the dose eliminated after 5 hr. Plasma desdipeated rapity from piasans, with an estimate of 50% of the dose eliminated after 5 hr. Plasma concentration-time data were analyzed using a three-compartment model and by the statistical moment method; both analyses yielded similar parameter estimates. The apparent steady-state volume of distribution (V sub ss) and the apparent volume of the deep peripheral compartment (V sub 3) increased exponentially with increasing temperature (log V proportional to temperature) while the volumes of the central (V sub 1) and shallow peripheral (V sub 2) compartments were not systematically affected. The total body clearance of DEHP increased linearly with increasing temperature, while the capacity to hold DEHP increased more rapidly, resulting in the biological persistence and potential for bioaccumulation of DEHP to increase with increased temperature. Both the terminal elimination half-life increased from 79.5 to minial elimination half-life increased from 79.5 to 130 hr between 6 and 18 C. Simulations with the model indicated that the distribution of DEHP was temperature sensitive; this finding may have important implications for the temperature sensitivity of DEHP toxicity or carcinogenicity. (Author's abstract) W87-09683

MUTAGENESIS OF THE METABOLITE OF NONIONIC DETERGENTS IN WATER, Howard Univ., Washington, DC. Dept. of Civil

Howard Univ., Washington, DC. Dept. of Civil Engineering.
M. M. Varma, L. Wan, and J. H. Johnson.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-172649/AS. Price codes: A03 in paper copy. A01 in microfiche. D.C. Water Resources Research Center, Washington, DC. Report No. 73, June 1986. 35 p, 5 tab, 30 ref. Contract No. 14-08-0001-G 1009. USGS Project No. G1009-02.

Descriptors: \*Nonionic detergents, \*Water pollu-tion sources, \*Water pollution effects, \*Mutagenic-ity, Nonylphenol, Ames test, Preincubation, Stand-ard procedure, Toxicity, Wastewater.

Biochemical decomposition of nonionic detergents under aerobic and anaerobic conditions yield a metabolite, 4-nonylphenol. The end use of nonionic detergents in this country is 140,000 tons per year. In addition nonlyphenol is widely used for manufacturing domestic, agricultural and industrial products. Due to its vast production and consumpproducts. Due to its vast production and consump-tion nonylphenol is found in European wastewater, sewage sludge and surface water. Toxicity testing

#### Effects Of Pollution-Group 5C

indicated that nonylphenol is twice more toxic than cadmium. Studies were conducted using Ames Standard and preincubation test procedures to determine the mutagenic activity of nonylphenol. Tester strains used were TA97, TA98, TA100, TA102, and TA104. Both spot test and preincubation tests were done with and without S9 activation. The results obtained showed that nonylphenol is not a mutagenic compound under the activation. The results obtained showed that non-iplience is not a mutagenic compound under the test conditions. Dose response studies showed that it was toxic at higher concentrations (100 micro-gram/plate). Nonlyphenol should be further tested for its toxicity to Salmonella strains. DDT and DDE were also not mutagenic as determined by the Ames test. (Varma-Howard Univ.)

AVAILABILITY AND DISTRIBUTION OF HEAVY METALS, NITROGEN, AND PHOS-PHORUS FROM SEWAGE SLUDGE IN THE PLANT-SOIL-WATER CONTINUUM,

Virginia Polytechnic man-burg. Dept. of Agronomy. ia Polytechnic Inst. and State Univ., Blacks-For primary bibliographic entry see Field 5B.

EVALUATING POTENTIAL GROUNDWATER CONTAMINATION FROM CONTAMINATED

Murray State Univ., KY. For primary bibliographic entry see Field 5B. W87-09754

ASSESSMENT OF THE TOXICITY AND MU-TAGENIC POTENTIAL OF WATER OF TORCH LAKE, HOUGHTON COUNTY, COUNTY,

MICHIGAN,
Michigan State Univ., East Lansing. Dept. of Biological Sciences.

logical Sciences.

R. Keen, and S. Bagley.

Available from the National Technical Information Service, Springfield, VA 22161, as PB86-158268/
AS. Price codes: A03 in paper copy, A01 in microfiche. Michigan Water Research Institute, East Lansing, Michigan. August 1985. 32 p, 38 ref. Contract No. 14-08-001-G913. USGS Project No. G913-02.

Descriptors: \*Michigan, \*Mutagenicity, \*Toxicity, Torch Lake, Ceriodaphnia, Daphnia, Ames test,

The toxicity and mutagenic potential of water of Torch Lake, Houghton County, Michigan, was measured. Torch Lake is unusual in having very large levels of dissolved copper in its water due to deposition of large amounts of spent copper ore (stamp sands') in over 100 years of copper mining activity. The presence of liver neoplasms in 100% of a species of fish (saugar) from Torch Lake has been presumptively associated with some features, probably chemical, of the massive stamp sand deposits in the lake. Because both toxicity and mutagenic potential of the lake water would be most evident at the upper end of the food chains due to bioaccumulation of materials dissolved in the water, tests for these effects were conducted with concentrations of water samples from Torch Lake, and from Otter Lake (Houghton County, Michigan) as a control. Water samples were collected at four different times in the lakes' annual thermal cycle, from three depths in Torch Lake and one depth in Otter Lake. The samples were fullered and concentrated using both low temperature evaporation and XAD-2 resin. Toxicity was measured using the Ceriodaphnia '-day life-cycle chronic toxicity test. Mutagenic potential was measured using the Ames Salmonella/microsome mutagenicity assay (Ames test). The 10x surface concentrates from Torch Lake were not significantly more toxic than Otter Lake samples. Concentrates from middepths and bottom waters in early June and late July were more toxic than surface concentrates. None of the Torch or Otter Lake concentrates were mutagenic in the Ames test, at equivalent test volumes of up to 1333 ml. (Keen-Mich. Tech. Univ.) W87-09755

OPTIMIZATION OF RECREATIONAL PO-TENTIAL IN NUTRIENT-ENRICHED LAKES BY CONTROL OF FISH POPULATIONS, Michigan State Univ., East Lansing. Dept. of Fisheries and Wildlife.

eries and Wildlife.

D. L. King, J. Ervin, L. Wolfson, and M. Wessels.

Available from the National Technical Information
Service, Springfield, VA 22161, as PB86-158276/
AS. Price codes: A03 in paper copy, A01 in microfiche. Michigan Water Research Institute, East
Lansing, Michigan, 1985. 33 p., 38 ref. Contract
No. 14-08-001-G913. USGS Project No. G913-03.

Descriptors: \*Weed control, \*Eutrophic lakes, \*Michigan, Lakes, Herbicides, Fish management, Algal control, Plankton, Kinetics, Biocontrol.

Michigan, Lakes, Herbicides, Fish management, Algal control, Plankton, Kinetics, Biocontrol.

Attempts to control excessive weed and algal growth in nutrient-enriched lakes have largely depended on herbicide applications often with unsatisfactory results. An alternative method, that of controlling fish populations and thus predation of zooplankton, may result in relief from algal blooms. In addition, variations in fish population can alter the entire ecology of nutrient-enriched lakes. Population estimates of phytoplankton, zooplankton, and fish were determined in three lakes over a one and one-half year period. Fish predation by abundant minnows in the first lake reduced cladoceran populations to the point where algae could accumulate sufficiently. As a result, light intensity was reduced to levels favoring blue-green algal dominance. Low fish populations in the second and third lakes did not severely reduce cladocerans, and cladoceran grazing on algae resulted in clear water and high light penetration, but abundant macrophytic and periphyton growth was observed. Decreasing the light intensity was a primary factor leading to development of dense bluegreen algal blooms. Phytoplankton increased when cladocerans decreased as a function of increased fish abundance. Young of the year bluegill exhibited an annual specific growth rate of 0.021/day in the third lake while the annual specific growth rate of a green suntish x bluegill hybrid in the second lake was 0.022/day. Supplemental laboratory studies showed that increased grazing rate of Daphnia pulex led to increased growth rate of the species which accelerated its reproduction. The specific growth rate of the paphnia population was a threshold-corrected hyperbolic function of the grazing rate. (Wolfson-Mich. State Univ.)

EFFECTS OF MATERNAL EXPOSURE OF RAINBOW TROUT TO 2,3,7,8-TETRACHLOR-ODIBENZO-P-DIOXIN (TCDD) ON REPRO-

ODIBENZO-P-DIOXIN (TCDD) ON REPRO-DUCTION, Michigan State Univ., East Lansing. Dept. of Fish-eries and Wildlife. F. M. D'Itri, and J. P. Giesy. Available from the National Technical Information Service, Springfield, VA 22161, as PB3-172631/ AS. Price codes: A03 in paper copy, A01 in micro-fiche. Michigan Water Research Institute, East Lansing, Michigan. Publication No. G1024-04, June 1986. 33 p. 3 fig. 1 tab, 54 ref. Contract No. 14-08-0001-G1024. USGS Project No. G1024-04.

Descriptors: \*Fish, \*Bioassay, \*Toxicity, \*Dioxins, \*Dibenzofurans, \*Trout, Great Lakes, Salmonids, Fish eggs, TCDD, PCDD, PCDF, Salmo gaird-

The rainbow trout (Salmo gairdneri) was selected as the experimental organism for several reasons: (1) background information on the effect of TCDD on growth and survivorship of fingerlings and adult fish is available for this species so that initial estimates of doses could be calculated; (2) information on the kinetics of uptake and depuration as well as bioconcentration factors are available for this species; (3) Plans to work with a salmonid species which occurs in the Great Lakes; (4) the rainbow trout spawns at a smaller size than lake trout or the salmon species so that the logistics for exposure are manageable; (5) there is a body of literature on the biochemistry, physiology, and histology of this species so that TCDD-induced changes can be interpreted; and (6) there is a body of literature on the effects of other stressors on this species, including compounds similar to TCDD,

such as polychlorinated biphenyls (PCB). During the past year, a state of the art negative pressure exposure OSHA approved exposure facility has been constructed and tested to conduct experibeen constructed and tested to conduct experiments on the effects of long-term, chronic exposures of extremely small concentrations (part per quadrillion) of toxic chemicals on two Great Lakes salmonid fishes. Because experimental and logistic problems related to the construction of this unique facility it is the primary output of the funding period. This experimental work continues and will represent a significant contribution to the field of ecological toxicology. (USGS)

EFFECTS OF ACID PH ON EMBRYONIC AND JUVENILE FRESHWATER FISH, Kentucky Water Resources Research Inst., Lex-

ington.

B. A. Ramey, and L. A. Colten.

Available from the National Technical Information
Service, Springfield, VA 22161, as PB87-159356/
AS. Price codes: A04 in paper copy, A01 in microfiche. Report No. 164, August 1986. 47 p. 6 fig. 12 tab, 60 ref. Contract No. 14-08-0001-G1019. USGS Project No. G1019-03.

Descriptors: \*Acid streams, \*Fish toxins, \*Hydrogen ion concentrations, \*Sulfuric acid, \*Bicassay, Aquatic life, Water pollution effects, Juvenile fish, Bluegills, Fathead minnows.

The effects of sulfuric acid on embryos, larvae, and juvenile fish were examined using standard bioassay techniques, as well as in a preference/avoidance behavioral test. The objectives were to compare the sensitivities of the various ages of fish to acid and to assess the use of the behavioral test in a hazard assessment program. In an 8-day renewal bioassay, embryos and larvae of the fathead minnow were not affected at a pH of 4.92 and above, but pH 3.57 produced complete mortality prior to hatching. In 96-hr acute bioassays, 8-wk juvenile fathead minnows survived 100 percent at pH's of 5.02 to 7.38, while complete mortality occurred at pH's below 3.90. At pH 4.29, only 15 percent of the population survived. Similar results were obtained with 12-wk animas. Juvenile bute were obtained with 12-wk animas. Juvenile bute with 3 so were exposed to various concentrations of sulfuric acid in a preference/avoidance bioassay. wk) also were exposed to various concentrations of Shirtine acid in a preference/avoidance bioassay. Both 14-wk fathead minnows and 8-wk bluegill sunfish avoided acid pH's below pH 6.0, while the 6-wk fathead minnows avoided all acid levels tested (i.e., pH 6.19 and below). Therefore, the 6-wk fathead minnows appeared to be the most sensitive to acid stress. Based on these findings, juvenile fish, given a choice, would tend to avoid acid levels that might not prove lethal to them. Therefore, the preference/avoidance bioassay should not be used alone but could be an important tool in evaluating sublethal effects in a multistage hazard assessment program. (Huffsey-WRRI, Univ. of KY)

ARSENIC, NITRATE, IRON, AND HARDNESS IN GROUND WATER, GOLDSTREAM ROAD, YANKOVICH ROAD, AND MURPHY DOME ROAD AREAS, (T.IN., R.2W., FM) FAIRBANKS,

ALASKA, Geological Survey, Fairbanks, AK. Water Resources Div.

For primary bibliographic entry see Field 5B. W87-09834

ATTENUATION OF METALAXYL ON POTATO LEAVES BY SIMULATED ACIDIC RAIN AND RESIDENCE TIME, Boyce Thompson Inst. for Plant Research, Ithaca, NY.

NY.
A. H. C. van Bruggen, M. G. Milgroom, J. F.
Osmeloski, W. E. Fry, and J. S. Jacobson.
Phytopathology PHYTAJ, Vol. 77, No. 3, p 401406, March 1987. 4 fig, 5 tab, 28 ref.

Descriptors: \*Water pollution effects, \*Acid rain, \*Metalaxyl, \*Plant tissues, \*Leaves, \*Potatoes, Fungicides, Rainfall, Pesticides, Simulated rainfall, Rainfall duration, Model studies, Mathematical equations, Hydrogen ion concentration

#### Group 5C-Effects Of Pollution

Greenhouse-grown rooted potato cuttings (cultivars Norchip and Monona) were sprayed with 200 ppm metalaxyl 78, 30, 6, or 0 hours before exposure to simulated rain at pH 2.8, 3.4, 4.0, or 4.6 at an intensity of 8.8 mm/hr for 0, 10, 20, or 30 minutes. The experiment was repeated with shorter minutes. The experiment was repeated with shorter time intervals between applications of the fungicide and simulated rain (0, 3, 6, 30, and 54 hours) and shorter rainfall durations (0, 3, 6, 10, and 20 minutes). Metalaxyl content of foliar tissue was determined by a bioassay with Phytophthora boehmeriae after chemical extraction. At the end of each experiment, plants treated with metalaxyl and simulated rain were inoculated with P. infestans to determine residual activity of the fungicide in situ. determine residual activity of the fungicide in situ. The concentration of metalaxyl declined exponentially with time after application and with rainfall duration, until asymptotes were reached about 30 hours after spraying or after 10 minutes of simulated rain (1.47 mm of rain). Fungicide wash-off was not affected by the acidity of rain or cultivar. Attenuation of metalaxyl over time and by rain was predicted accurately by an exponential decay model with an asymptote. Despite a rapid initial decrease in metalaxyl concentration, residual concentrations (5-10% of the original deposit) were centrations (5-10% of the original deposit) were still sufficient to control late blight. (Author's abstract) W87-09920

DIURNAL PATTERNS OF AMMONIUM LOADING AND LOSS IN A STREAM RECEIV-ING SECONDARY TREATMENT EFFLUENT, IOWA STATE UNIV., Ames. Dept. of Botany. For primary bibliographic entry see Field 5B. W87-09952

STUDIES OF UPTAKE AND TOXIC EFFECTS OF CR(VI) ON PISTIA STRATIOTES, Visva-Bharati Univ., Santiniketan (India). Dept. of For primary bibliographic entry see Field 5B. W87-10055

EFFECTS OF ENVIRONMENTAL PH ON AM-MONIA EXCRETION, BLOOD PH, AND OXYGEN UPTAKE IN FRESH WATER CRUS-TACEANS

HACEANS, Hartwick Coll., Oneonta, NY. Dept. of Biology. N. A. Mauro, and G. W. Moore. Comparative Biochemistry and Physiology (C) CBPCEE, Vol. 87, No. 1 p 1-3, 1987. 1 fig, 3 tab,

Descriptors: \*Acid rain, \*Acidic water, \*Crusta-ceans, \*Water pollution effects, \*Ammonia, \*Hy-drogen ion concentration, Oxygen, Fresh water.

In Procambarus clarki and Procambarus fallax, ammonia excretion increases in resonate to low ambient water pH. These findings do not differentiate between the alternative hypotheses that the reduction in ambient water pH (a) stimulates the reduction in ambient water pH (a) stimulates the passive diffusion of ammonia, and/or (b) inhibits Na(+)/NH4(+) ATPase activity. The ammonia excretory rate of Orconectes rusticus remains constant with changes in water pH. In normoxic water, oxygen uptake in P. clarki and O. rusticus is maintained in response to changes of ambient water pH. (Author's abstract)

ENHANCED COPPER TOXICITY RESULTING FROM ENVIRONMENTAL STRESS FACTOR SYNERGIES,

SYNERGIES, Hong Kong Univ. Dept. of Physiology. M. H. Depledge. Comparative Biochemistry and Physiology (C) CBPCEE, Vol. 87, No. 1 p 15-19, 1987. 4 fig, 1 tab,

Descriptors: \*Synergistic effects, \*Water pollution effects, \*Copper, \*Toxicity, \*Crustaceans, Respiration, Hypoxia, Salinity, Survival.

Circulatory and respiratory responses of Carcinus maenas to various combinations of salinity stress, progressive hypoxia and copper pollution (10 mg/L) have been investigated. Salinity stress (0.8%)

was associated with increased heart rate and oxygen consumption. In contrast, simultaneous exposure to salinity stress and copper ions resulted in bradycardia and a progressive reduction in aerobic metabolism. Hypoxia evoked bradycardia and supression of oxygen consumption below a critical oxygen tension (P sub c) in the range 66-80 mmHg. Similar responses were exhibited when copper ions were present although perfusion indices (Q/V sub 02) were elevated. During simultaneous exposure to all three stress factors responses to hypoxia predominated. Environmental stress factors synergistically enhanced copper toxicity resulting in ca 40% mortality with copper + salinity stress, 100% mortality together with reduction of time to death with copper - hypoxia + salinity stress. (Author's abstract).

EFFECT OF WATER-SOLUBLE FRACTION OF COOK INLET CRUDE OIL ON SWIMMING PERFORMANCE AND PLASMA CORTISOL IN JUVENILE COHO SALMON (ONCORHYN-CHUS KISUTCH),
California State Univ., Chico. Dept. of Biological

R. E. Thomas, and S. D. Rice.
Comparative Biochemistry and Physiology (C)
CBPCEE, Vol. 87, No. 1 p 177-180, 1987. 2 fig, 24

Descriptors: \*Oil pollution, \*Water pollution effects, \*Swimming, \*Fish physiology, \*Salmon, \*Crude oil, Population exposure, Fish, Stress.

Swimming performance of juvenile coho salmon decreased and plasma cortisol increased, following 48-hr exposure to the water-soluble fraction (WSF) of Cook Inlet crude oil at 75% of the LC50. Exposure to 25 and 50% of the LC50 did not significantly reduce swimming performance. Plasma cortisol concentrations were highest in fish exposed to both the combined stress of WSF exposure and of forced swimming in a stamina tunnel. (Author's abstract)

EFFECTS OF SELENIUM ON THE DISTRIBU-TION OF MERCURY IN THE ORGANS OF THE BLACK BULLHEAD (ICTALURUS

THE BLACK BULLHEAD (ICIALURUS MELAS), South Dakota Univ., Vermillion. Dept. of Biology. D. Jorgensen, and J. F. Heisinger. Comparative Biochemistry and Physiology (C) CBPCEE, Vol. 87, No. 1 p 181-186, 1987. 4 fig, 3

Descriptors: \*Water pollution effects, \*Path of pollutants, \*Mercury, \*Selenium, \*Bullhead, Heavy metals, Tissue analysis.

Following i.p. mercuric chloride injections, the mercury was deposited primarily in the kidneys. Simultaneous selenium injections prevented mercury induced osmoregulatory failure even though selenium strongly promoted the movement of mercury to the kidneys and its deposition in an approximate 1:1 mercuric selenite ratio. Whole-body re-tention of mercury was not altered by simultaneous subcutaneous injections of sodium selenite. (Author's abstract)
W87-10079

PARAQUAT AS AN AGENT AFFECTING AN-TITOXIDANT ENZYMES OF COMMON CARP ERYTHROCYTES, Jozsef Attila Univ., Szeged (Hungary). Biological

Isotope Lab.
B. Matkovics, H. Witas, T. Gabrielak, and L.

Comparative Biochemistry and Physiology (C) CBPCEE, Vol. 87, No. 1 p 217-219, 1987. 1 fig, 21 ref. Contract R.III. 13.2.3.

Descriptors: \*Water pollution effects, \*Paraquat, \*Enzymes, \*Carp, \*Antioxidants, Population exposure, Blood, Erythrocytes.

The effects of paraquat on the superoxide dismutase, catalase, flutathione peroxidase activities and

lipid peroxidation at different times of paraquat exposure of Cyprinus carpio morph L. erythrocytes were studied. Typical characteristics were observed in the changes of the enzyme activities of the erythrocytes after exposure to paraquat. The hemoglobin concentration of common carp haemolysates was decreased by exposure to paraquat. (Author's abstract) W87-10080

EFFECTS OF 'PRISTINE' AND 'INDUSTRIAL' SIMULATED ACIDIC PRECIPITATION ON GREENHOUSE GROWN RADISHES, Virginia Polytechnic Inst. and State Univ., Blacks-

burg. Dept. of Plant Pathology and Physiology. R. L. Olson, W. E. Winner, and L. D. Moore. Environmental and Experimental Botany EEBODM, Vol. 27, No. 2, p 239-244, April 1987. 3 tab, 15 ref. CSRS Grant SGP-0010-1983.

Descriptors: \*Crop yield, \*Water pollution effects, \*Acid rain effects, \*Acid rain, \*Radishes, \*Simulated rainfall, Rainfall, Plant physiology, Drought

To test the effects of industrial rain on radish growth, two simulated rain solutions, at pH 4.8 and pH 4.0, were used. The solutions had ionic concenpH 4.0, were used. The solutions had ionic concentrations similar to average rainfall in Katherine, Australia and the Eastern United States, respectively, and were labeled 'pristine' and 'industrial.' These solutions were applied to greenhouse-grown radish every other day for 1 hr at the rate of 1 cm/hr, and the plants were harvested on day 30 after germination. In two trials, the major effect of the industrial rain treatment was to decrease root dry weight. Such a growth change could have major effects upon plant vigor, including decreased drought resistance and structural stability. (Author's abstract) thor's abstract) W87-10085

PATTERN OF ORGANIC MATTER PRODUCTION BY NATURAL PHYTOPLANKTON POPULATION IN A EUTROPHIC LAKE 2. EXTRACELLULAR PRODUCTS,
Nagoya Univ. (Japan). Water Research Inst.
For primary bibliographic entry see Field 2H.
W87-10095

#### 5D, Waste Treatment Processes

MILLISCREENING: A PRETR OPTION FOR MARINE DISPOSAL, PRETREATMENT Hutt Valley Drainage Board, Lower Hutt (New Zealand).

Water Science and Technology WSTED4, Vol. 18, No. 11, p 71-81, 1986. 5 fig, 7 tab, 4 ref.

Descriptors: \*Wastewater treatment, \*Milliscreening, \*Wastewater disposal, \*Outfall, \*Waste disposal, \*Wastewater, Coastal waters, Effluents, Design criteria, New Zealand.

The Hutt Valley Drainage Board Milliscreen Treatment Plant, commissioned in July 1984, treats municipal waste using 0.5mm and 1.0mm wedgewire single pass rotary screens. The plant is designed to remove all gross solids not readily assimilated by the sea and is an alternative to primary treatment prior to discharge into coastal waters via a marine outfall. This paper describes the plant and background to the investigations, milot plant studies design, and operational data pilot plant studies, design, and operational data available to date. Milliscreening as a pretreatment option for marine disposal is also discussed. (Author's abstract) W87-09639

EVALUATION OF THE EFFICIENCY OF SANTOS/SAO VICENTE PRECONDITIONING STATION FOR AN OCEANIC SUBMARINE

OUTFALL,
Companhia de Tecnologia de Saneamento Ambiental, Sao Paulo (Brazil).
E. G. Agudo, R. Amaral, and G. Berzin.
Water Science and Technology WSTED4, Vol.

#### Waste Treatment Processes—Group 5D

18, No. 11, p 83-91, 1986. 6 fig. 4 tab, 8 ref.

Descriptors: \*Wastewater treatment, \*Wastewater pretreatment, \*Wastewater disposal, \*Outfall, \*Wastewater, Coastal waters, Effluents, Suspended solids, Oxygen demand.

The efficiency of solids removal and the resultant effect on submarine outfall performance of the The efficiency of solids removal and the resultant effect on submarine outfall performance of the sewage preconditioning station of Santos and Sao Vicente cities are evaluated. Emphasis is given to the removal of floatable materials that could the removal of floatable materials that could emerge on the water surface. It was found that most floatables are disaggregated in the pumping process, thus changing their floating properties. The efficiency of the removal of floating materials by the milliscreens of size of openings 1.5 mm is about 70%; of the remaining floatables that are pumped to the submarine outfall, only about 50% appear on the water surface. The removal efficiencies for biochemical oxygen demand (BOD), chemical oxygen demand (COD), and suspended and settleable solids are much lower than those seen with milliscreens with smaller openings. (Author's abstract) thor's abstract) W87-09640

MEETING THE WATER QUALITY CRITERIA FOR THE METAL FINISHING INDUSTRIES, Texas Instruments, Inc., Attleboro, MA. F. J. Veale, and M. J. Elliott. Environmental Progress ENVPDI, Vol. 6, No. 2, p 67-73, May 1987. 1 fig, 4 tab, 7 ref.

Descriptors: \*Wastewater treatment, \*Heavy metals, \*Water quality, Effluents, Wastewater, Massachusetts, Toxicity, Clean Water Act.

In July of 1977, Texas Instruments in Massachusetts was issued a five-year National Pollutant Discharge Elimination System (NPDES) permit in compliance with the Clean Water Act (CWA). The company had just completed the installation of a modern waste treatment facility employing metal hydroxide precipitation. This system was considered the Best Available Technology (BAT), and it was the search of the control metal hydroxide precipitation. This system was considered the Best Available Technology (BAT), and it was based on such process chemistry criteria that the original permit limits were generated. In 1982, when Texas Instruments submitted a renewal application for its NPDES discharge permit, water quality criteria were used in place of BAT to determine the permit limits. Since it had been shown that BAT was insufficient to achieve water qualities in receiving streams equal to their designated uses, the EPA, in compliance with Section 301 (b)(1)(c) of the CWA, began imposing much more stringent limits to attain the necessary water quality standards. Furthermore, the Massachusetts Water Quality Standards, 314 CMR 4.00, required that all waters must be free of toxic substances in amounts or combinations that would impair the most sensitive water uses. Therefore, the draft NPDES permit issued to Texas Instruments in January of 1984 reflected the stringent water quality guidelines. Texas Instruments then faced a difficult decision on whether to attempt to relieve the tight proposed limits through aquatic toxicity testing, or whether to redirect the effluent to another the textical contents the string of the contents the str ing, or whether to re-direct the effluent to another receiving stream (i.e. Publically Owned Treatment Works), or in the worst case, whether to shutdown its large Attleboro based manufacturing facility employing over 5000 people and relocate to another area. In the final analysis and after much deliberation, T1 chose to maintain its Attleboro facility and enter into a long and relatively unexplored avenue of aquatic toxicity testing to raise its permit limits to achievable levels. Even if T1 succeeded in raising the limits, the existing waste treatment facility would probably require more modifications. As one of the first industries in the New England region to negotiate an NPDES permit based on the new water quality criteria, this article explores the protocol and method by which a new permit was established at Texas Instruments. (Author's abstract) (Author's abstract) W87-09656

METHODS FOR REMOVAL OF COPPER AND IRON FROM BOILER CHEMICAL CLEANING WASTES,

Radian Corp., Austin, TX.

L. J. Holcombe, G. P. Behrens, and W. C. Micheletti.
Environmental Progress ENVPDI, Vol. 6, No. 2, p 74-81, May 1987. 7 tab, 7 ref, append.

Descriptors: \*Copper, \*Iron, \*Wastewater treatment, \*Heavy metals, \*Water quality, Effluents, Wastewater, Field tests, Boilers, Maintenance.

Wastewater, Field tests, Boilers, Maintenance.
Field and laboratory studies were conducted to evaluate treatment methods for reducing the concentrations of dissolved copper and iron in several spent boiler cleaning solutions. These waste solutions are generated during the cleaning of steam tubes in utility boilers. Cleaning may be accomplished using one of several solutions, including: inhibited hydrochloric acid, ammonium bromate, ethylenediamine tetraacetic acid (EDTA), citrate, each hydroxyacetic-formic acid. The raw wastes were treated by conventional lime and caustic precipitation and by co-ponding with coal fly ash. The conventional treatment was capable of treating hydroxyacetic formic acid and hydrochloric acid wastes to comply with the Federal effluent discharge guidelines (NPDES) of 1 mg/l for Cu and Fe. Ammonium bromate solutions may require dilution prior to treatment to precipitate Cu. Citrate and EDTA based wastes were more difficult to treat and required additional processing steps. Coponding in alkaline ash ponds was successful for all wastes tested. The neutral ash did not perform well with citrate or EDTA wastes. The acidic ash did not achieve 1 mg/L Cu or Fe levels with any waste type. (Peters-PTT)

FIELD EVALUATION OF ARSENIC AND SE-LENIUM REMOVAL BY IRON COPRECIPI-

LENUM REPUTAL BI INON
TATION,
Brown and Caldwell, Walnut Creek, CA.
D. T. Merrill, M. A. Manzione, D. S. Parker, J. J.
Petersen, and W. Chow.
Environmental Progress ENVPDI, Vol. 6, No. 2,
p 82-90, May 1987. 11 fig, 18 ref.

Descriptors: \*Arsenic, \*Selenium, \*Wastewater treatment, \*Heavy metals, \*Water quality, Effluents, Wastewater, Coprecipitation, Field tests,

Trace elements.

The priority trace elements arsenic and selenium were removed from ash pond effluent by iron coprecipitation in a field study at the Carolina Power and Light Company's Roxboro Station. The study's broad objectives were to verify previously-derived laboratory results, confirm the technology's technical and economic feasibility, and develop information that could be used to make preliminary designs and cost estimates for full-scale treatment plants. The technology was tested at pilot scale in a continuous-flow system under field conditions. A chemical coagulation system was used of the kind typically employed for municipal and industrial water treatment. Arsenic was strongly removed (90 percent and above) with moderate iron dosages (14 mg/L to 28 mg/L Fe). Selenium removals were lower (56 to 80 percent) under comparable chemical conditions. Arsenic and selenium removals were strongly affected by solution pH. Testing indicated that process sludges can be gravity thickened, then dewatered with filter presses to 25 to 35 percent solids. Dewatered pilot sludges were determined to be not hazardous, as defined by Extraction Procedure (EP) toxicity test criteria. Total process costs for the Roxboro site are estimated to be 9.3 cents/cu m (335) per million gallons). This cost is for a facility that processes an average flow of 1.1 cu m/sec (26 mgd) and uses an iron dose of 14 mg/L, as Fe. The facility is sized to process a peak flow of 1.5 cu m/sec (35 mgd). (Author's abstract)

REMOVAL OF HEAVY METALS IN POTW, Rensselaer Polytechnic Inst., Troy, NY. Dept. of Chemical and Environmental Engineering. D. B. Aulenbach, M. A. Meyer, E. Beckwith, S. Joshi, and C. Vasudevan.

Environmental Progress ENVPDI, Vol. 6, No. 2, p 91-98, May 1987. 4 fig, 7 tab, 12 ref. EPA Project CR-809226.

Descriptors: \*Activated sludge, \*Sedimentation, \*Wastewater treatment, \*Heavy metals, \*Water quality, Effluents, Wastewater, Mercury, Arsenic.

Studies were conducted at three activated sludge treatment plants during normal operation. The heavy metals on the priority pollutants list were measured in the influent to each plant, the primary sedimentation effluent where applicable, the discharge after activated sludge treatment and secondary sedimentation, and in one case after a final polishing filter. Both the soluble and the total portions were measured. Beryllium, nickel, and thallium were not found in detectable levels in any of the plant influents. Mercury was found in only of the plant influents. Mercury was found in only of the plant influents. Mercury was found in only trace amounts. The removals of the other metals varied considerably. No consistent conclusions can be made from the data; each metal, soluble or total be made from the data; each metal, soluble or total fraction, and unit treatment operation must be interpreted individually. The only metal in the plant effluents consistently above the recommended limit was arsenic, and this barely above the limit. The only other metal present in the effluent above the recommended limit was the lead content from Fitchburg, despite 83% removal of this metal in the treatment system. (Author's abstract) W87-09659

REMOVAL OF RADIOACTIVE CONTAMINANTS FROM WEST VALLEY WASTE STREAMS USING NATURAL ZEOLITES, Westinghouse Electric Corp., Pittsburgh, PA. Research and Development Center.
D. C. Grant, M. C. Skriba, and A. K. Saha.
Environmental Progress ENVPDI, Vol. 6, No. 2, p 104-109, May 1987. 3 fig. 8 tab, 2 ref. DOE Contract DE-ACO7-81-NE44139.

Descriptors: \*Radioactivity, \*Zeolites, \*Wastewater treatment, \*Heavy metals, \*Water quality, Effluents, Wastewater, New York, Ion exchange.

A variety of low-level radioactive waste streams are being generated from the decontamination and decommissioning of the former nuclear fuel re-processing plant at West Valley, New York, It is processing plant at west valuey, New 107s. It is planned to remove the radioactive contaminants from the solutions by ion exchange. Natural zeolities, such as clinoptilolite, erionite, chabazite, and phillipsite, provide desired flexibility and capacity under varying conditions. Batch and column testing were conducted on these materials using representative waste, streams containing radioactive. sentative waste streams containing radioactive cesium, strontium, and cobalt. Based on clumn test data, the phillipsite and clinoptilolite appear to be the most attractive materials. Erionite has potential flow difficulties and chabazite has shown lower cesium decontamination factors than the other zeo-lites. The natural zeolites have shown some difficulty in meeting the strontium discharge limit (3 x 10 th the minus 7th power micron c:/ml). Testing on the nitric acid waste has shown that decreasi the residence time in the zeolite column from 20 to 5 minutes will result in reduced cesium loading and decontamination factors. The present design of the actual system will allow at least 20 minutes residence time. The testing on this waste stream also indicated that the strontium loading can be adversely affected by the solution pH. A pH of 5 versely affected by the solution pH. A pH of 5 results in a very low loading. Future testing will determine whether or not the strontium loading can be improved by increasing the pH to between 7 and 8. (Peters-PTT) W37-09661

ACTIVATED CARBON ADSORPTION OF HEAVY METAL CHELATES FROM SINGLE AND MULTICOMPONENT SYSTEMS, Kentucky Univ., Lexington. Dept. of Chemical

Reintexly Ohry, Lexington, Dept. of Chemical Engineering. D. Bhattacharyya, and C. Y. R. Cheng. Environmental Progress ENVPDI, Vol. 6, No. 2, p 110-118, May 1987. 13 fig, 3 tab, 14 ref. EPA Grant CR-807760.

Descriptors: \*Activated carbon, \*Adsorption, \*Wastewater treatment, \*Heavy metals, \*Water quality, Effluents, Wastewater, Kinetics, Ligands.

An extensive experimental investigation was con-ducted with activated carbon to establish the ad-

#### **Group 5D—Waste Treatment Processes**

sorption (equilibrium and kinetics) behavior of several metals from single and two metals systems in the presence of complexing agents. Triethylenetetramine (TRIEN) and EDTA were used as complexing agents. The extent of adsorption was found to be a function of metal and ligand types, ligand to metal ratio, pH, and metal chelate species distribution. Selective separation of valuable metals can also be achieved by the addition of complexing ligands to a mixture of strongly complexable metal (such as Cd(2+) and Ni(2+)) and weakly complexable metal (such as Ba(2+) and Ca(2+)). (Author's abstract) sorption (equilibrium and kinetics) behavior of sev-

INNOVATIVE USES FOR CARBON ADSORP-TION OF HEAVY METALS FROM PLATING WASTEWATERS: I. ACTIVATED CARBON PO-LISHING TREATMENT, Purdue Univ., Lafayette, IN. Dept. of Environ-

Purdue Univ., Language, and Language, and Language, Y. Ku, and R. W. Peters. Environmental Progress ENVPDI, Vol. 6, No. 2, p 119-124, May 1987. 5 fig. 4 tab, 23 ref.

Descriptors: \*Activated carbon, \*Polishing, \*Wastewater treatment, \*Heavy metals, \*Water quality, Effluents, Wastewater, Sulfides, Plating, Hydroxides

Activated carbon treatment as a polishing step following either metal hydroxide or metal sulfide precipitation is effective for removal of residual zinc, cadmium, and excess sulfide from plating wastewaters. When hydroxide precipitation is employed, the use of activated carbon allows significantly lower effluent metal concentrations to be achieved; the residual zinc and cadmium concentrations were reduced in excess of 70% with the use of activated carbon following hydroxide pretrations were reduced in excess of 10% with the use of activated carbon following hydroxide precipitation. In the absence of chelating agents and other interferences, removal of zinc exceeded 70% and sulfide removal exceeded 50% over the pH and sulfide removal exceeded 50% over the pH range of 7 to 10 by employing the activated carbon polishing step. With 100 mg/L of ammonia or cyanide (acting as interferences) present, zinc removal following sulfide precipitation was typically reduced 50%. For waters high in sulfides, removals exceeded 74%. The activated carbon polishing step shows great promise as a treatment alternative to minimize the potential for H2S gas evolution and the sulfide toxicity associated with sulfide precipitation of heavy metals. (See also W87-09664) (Author's abstract)

II. SEEDING THE METAL HYDROXIDE/ METAL SULFIDE REACTOR WITH ACTIVAT-

METAL SULFIDE REACTOR WITH ACTIVATED CARBON,
Purdue Univ., Lafayette, IN. Dept. of Environmental Engineering.
R. W. Peters, and Y. Ku.
Environmental Progress ENVPDI, Vol. 6, No. 2,
p 125-132, May 1987. 10 fig, 7 tab, 19 ref. PRF
Grant 690-1284-1209.

Descriptors: \*Activated carbon, \*Seeding, \*Wastewater treatment, \*Heavy metals, \*Water quality, Effluents, Wastewater, Sulfides, Hydroxides.

An innovative technology which involves seeding the metal hydroxide/metal sulfide precipitation rethe metal hydroxide/metal sulfide precipitation re-actor with activated carbon as a means of promot-ing the precipitation step. Based on the results of this preliminary study for the Zn(OH)2 system, significant metal removal enhancement can be achieved with this process. For long settling times (t > or = 30 minutes), little enhancement is ob-served over the case with no seeding. For short settling times, however, the residual metal concen-tration is approximately an order of magnitude setting times, however, the residual metal concentration is approximately an order of magnitude lower than the same case without the activated carbon seeding. For the case of seeding the reactor with Darco S51 activated carbon, operation at pH 10.5 is preferable to operation at pH 8.1 due to much lower residual metal concentrations being achieved. For operation at pH 10.5, seeding with Darco HD3000 proved superior to seeding with Darco S13 activated carbon; the residual concentrations Darco S51 activated carbon; the residual concentrations at the short detention time were about onehalf the concentrations achieved with Darco S51 activated carbon. For Darco HD3000, little improvement in heavy metal removal occurred for activated carbon dosages exceeding 50 mg/L. (See also W87-09663) (Author's abstract) W87-09664

DEVELOPMENT OF A DATA BASE FOR MODELLING ADSORPTION OF INORGANICS ON IRON AND ALUMINUM OXIDES,

Massachusetts Inst. of Tech., Cambridge. Ralph M. Parsons Lab.
D. A. Dzombak, and F. M. M. Morel

Environmental Progress ENVPDI, Vol. 6, No. 2, p 133-137, May 1987. 6 fig, 21 ref. EPA Grant CR-811181-01-01 and NSF Grant OCE-8118103.

Descriptors: \*Model \*Wastewater treatment, \*Heavy metals, \*Water quality, Effluents, Wastewater, Iron oxide, Aluminum oxide, Prediction.

Although there is an abundance of data for equilibrium adsorption of inorganic ions on hydrous oxides and surface complexation models are capable of fitting the data with only a few adjustable parameters, these models have not been used in practice because of the lack of consensus as to the 'best' model and the lack of a coherent compendibest model and the lack of a concrent compendi-um of equilibrium adsorption constants. To remedy this situation, a thermodynamic data base for inor-ganic adsorption is being developed from original data using a simple yet widely applicable model in which specific adsorption is assumed to take place in one surface layer and a Gouy-Chapman diffuse layer is assumed for the solution side of interface. The resulting data base can be included in general chemical equilibrium computer programs and used to predict adsorption (outside as well as within the range of calibrating data) in aqueous systems con-taining oxide surfaces. Both the model and the parameter extraction procedure are presented. In an example, surface complexation modelling is applied to a waste stream containing cadmium, lead. an example, surface complexation modelling is applied to a waste stream containing cadmium, lead, and mercury, all at 10 to the minus 7th power M, which is to be treated in a batch iron coprecipitation process. Using derived surface complexation constants, the effet of varying iron dose and pH on removal of cadmium, lead, and mercury was investigated and the results plotted. (Author's abstract) W87-09665

BIOLOGICAL REMOVAL OF CHLORINATED HYDROCARBONS FROM WATER.

Louisiana State Univ., Baton Rouge. Inst. for Environmental Studies.

P. H. Templet.
Available from the National Technical Information Available from the National Technical Information Service, Springfield, VA 22161, as PB86-170438.\(^{4}AS, A02 in paper copy, A01 in microfiche. Louisiana Water Resources Research Institute, Baton Rouge, October 1985. 20 p, 7 fig. 3 tab, 16 ref. Contract No. 14-08-0001-G909. USGS Project No. G-909-06.

Descriptors: \*Phenolic pesticides, \*Phenols, \*Water pollution treatment, \*Louisiana, Biological treatment, Aquatic plants.

With the hope of finding an inexpensive and simple solution to the problem of cleanup of contaminated water, this project investigated the role of freshwater plants in wastewater treatment. The use of ter plants in wastewater treatment. In e use of duckweeds (ternnaceae) to remove phenol and 2-chlorophenol from water offers an inexpensive and simple solution to the cleanup of contaminated water. The rate at which the organic compounds were removed from water by a known amount of duckweed was determined for three different conceptations of the control of the defiferent conceptations of the control of the defiferent conceptations. centrations of phenol and with three different amounts of duckweed for 2-chlorophenol. The duckweed removed phenol from water at a rate which is dependent on the phenol concentration and average 107 micrograms phenol removed/hr/g duckweed for the first 48 hours at 10 ppm initial g duckweed for the first 40 nous at 10 ppin linual concentration of phenol in water. The removal rate for 2-chlorophenol was investigated at a lower initial concentration (2.3 ppm) and the removal rate was slower and a function of the quantity of duckweed present even when normalized to a constant duckweed level. The rate increased for the

first 4-6 days and average 33 micrograms chlorophenol removed/day/g duckweed at the sixth day. The results support the hypothesis that duckweeds can be used to feasibly remove phenols and chlorophenols from water and offers the possibility of biological treatment of polluted waters and confirms the possibility of biological treatment of polluted waters. (Templet-Louiusiana St. Univ.)

CADMIUM REMOVAL AND RECOVERY BY MAGNESIUM CEMENTATION, Georgia Inst. of Tech., Atlanta. School of Civil

Engineering. J. P. Gould, H. F. Wiedeman, and B. M.

Khudenko. Available from the National Technical Information Available from the National Technical Information Service, Springfield, VA 22161, as PB87-179511/AS. Price codes: A04 in paper copy, A01 in microfiche. Environmental Resources Center, Georgia Institute of Technology, Atlanta. Report No. ERC 04-86, July 1986. 58 p. 9 tab, 46 fig, 36 ref. Contract No. 14-08-0001-G-1011. USGS Project No. G1011-04.

Descriptors: \*Wastewater treatment, \*Kinetics, \*Stoichiometry, \*Cadmium, \*Magnesium, \*Resource recovery, Hazardous wastes, Toxic substances, Industrial wastes, Waste treatment, Waste recovery, Physiochemical treatment, Chemical precipitation.

The kinetics of cementation of cadmium by magnesium were studied in a completely mixed batch reactor at room temperature and constant mixing rate and ionic strength. Magnesium strips provided in stoichiometric excess were used as electrodes. The effect of pH and initial cadmium concentration on the rate of cadmium removal and reaction tion on the rate of cadmium removal and reaction stoichiometry, or yield of magnesium consumed per cadmium cemented, were evaluated. The rate of cadmium removal was shown to be more independent of pH between 3 and 6. However, as pH increased, the process yield became more favorable. This was attributed to the competing reaction of magnesium dissolution which decreases with increasing pH. The rate of cadmium removal was studied at initial cadmium concentrations between 1 and 100 mM. It was found that the rate and stoichiometry were highly dependent upon initial cadmium concentration. At initial concentrations of up to approximately 25 mM, the reaction was found to follow apparent half order kinetics consistent with a migration control mechanism. As initial cadmium concentrations increased through initial cadmium concentrations increased through this range, removal rates also increased. At ap-proximately 25 mM, a transition was observed to apparent first-order kinetics consistent with a diffusion control mechanism. There was a significant decrease in removal rates as the initial cadmium concentration increased to levels of greater than 25 mM. Stoichiometry was found to become more favorable as initial cadmium concentration increased, and in some cases, less than 1 mole of magnesium was required to cement 1 mole of cadmium. This effect was attributed to electrolysis of water by the induced electrochemical system.
(Gould-GIT)
W87-09778

DESIGN AND OPERATION OF ADSORBERS TO ELIMINATE THE CHROMATOGRAPHIC DISPLACEMENT OF TOXIC COMPOUNDS, Clemson Univ., SC. Dept. of Environmental Sys-Engineering.

T. M. Keinath

T. M. Keinath.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB86-157104/
AS. Price codes: A08 in paper copy, A01 in microfiche. South Carolina Water Resources ResentInstitute, Clemson, Report No. 116, September
1985. 148 p. 42 fig. 28 tab, 44 ref, append. Contract
No. 14-08-0001-G-868; 14-08-0001-G-932. USGS
Project No. G-868-06-SC; G-9322-06-SC.

Descriptors: \*Adsorption, \*South Carolina, \*Activated carbon, \*Hysteresis, \*Adsorbents, \*Advanced wastewater treatment, \*Wastewater treatment, Wastewater treatment, Wastewater, Industrial Municipal wastewater, Wastewater, Industrial wastewater, Packed beds, Fluidized beds, Organic

#### Waste Treatment Processes—Group 5D

wastes, Phenols, Environmental control, Environmental quality.

Two mathematical relationships concerning ad-sorption equilibria were developed. One enables prediction of the full family of desorption isothprediction of the full family of desorption isotherms for single-solute systems given experimental data for one adsorption isotherm and one desorption isotherm. This is based on the Freundlich isotherm relationship. The second allows one to accurately predict multicomponent adsorption/desorption equilibria considering the effects of non-ideal adsorption and adsorption/desorption hysteresis. This latter model is a modified version of the simplified Ideal Adsorbed Solution (IAS) model that has served as the state-of-the-art model to that has served as the state-of-the-art model to date. The multicomponent adsorption equilibria model was subsequently used as a component of the Homogeneous Surface Diffusion Model (HSDM) to define, through computer based simu-lations, the specific design and operating criteria that serve to prevent the chromatographic dis-placement of adsorbed toxic organic chemicals from adsorbers used for industrial decontamination numbers. These simulations showed that (1) fluidfrom adsorbers used for industrial decontamination purposes. These simulations showed that (1) fluidized-beds offer advantages over packed-beds; (2) industrial production schedules should be arranged such that all toxic contaminants are always discharged simultaneously, if possible, or if not possible, that the highest-energy adsorbing contaminants are discharged first; and (3) equalization basins are highly beneficial. (Keinath-WRRI) W87-09784

PERFORMANCE EVALUATION OF A DETENTION BASIN AND COALESCING PLATE OIL SEPARATOR FOR TREATING URBAN STORMWATER RUNOFF, Washington Univ., Seattle. Dept. of Civil Engi-

Washington Univ., Seattle. Dept. of Civil Engineering.
R. R. Horner, and S. R. Wonacott.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB86-153665/
AS. Price codes: A04 in paper copy, A01 in microfiche. Water Resources Series Technical Report
No. 98, June 1985. 52 p, 5 fig. 7 tab, 40 ref.
Contract No. 14-08-0001-G940. USGS Project No.
G940-06 (A-130-WASH).

Descriptors: \*Urban runoff, \*Washington, \*Wastewater treatment, \*Detention reservoirs, \*Water pollution control, Storm runoff, Water

Stormwater runoff from land surfaces put to various uses has been identified as a major factor in the degradation of receiving water bodies. Detention devices and oil/water separators are two of the runoff treatment measures being used to alleviate this problem. However, there has been little basis on which to design and operate these facilities to obtain maximum treatment effectiveness. The general goal of this project was to contribute to defining the needed basis by collecting and analyzing operating data on a detention basin/coalescing plate oil separator treatment system in Bellevue, Washington. Three natural and four synthetic storms were monitored at the site between November 1984 and May 1985. Site runoff was sampled at the inlet and oulet of the detention pond and the separator discharge and analyzed for suspended solids, seven metals, total phosphorous, nitrate + nitrite - nitrogen, and soil and grease. Removal efficiencies of the treatment devices were computed and evaluated with reference to antecedent and storm conditions. The experiments demonstrated that the detention pond removes the majority of the entering solids, nearly all of the lead, 1/4 to 1/3 of the phosphorous, and variable proportions of nitrogen and other metals. Oil and grease concentrations in the runoff from the site were very low, and the capacity of the coalescing plate oil/water separator was not utilized. Unidentified materials in the separator added substantial quantities of zinc to the runoff. Although oil/water separators are in the separator added substantial quantities of zinc to the runoff. Although oil/water separators are necessary at sites with more heavy equipment and automobile traffic, their use could be limited to areas prone to oil spills. Land treatment of deten-tion pond effluent appears to be a more cost-effective alternative for such applications. (Horner-WSU) W87-09796

DESIGN, OPERATION, AND MONITORING CAPABILITY OF AN EXPERIMENTAL ARTIFICIAL-RECHARGE FACILITY AT EAST MEADOW, LONG ISLAND, NEW YORK, Geological Survey, Syosset, NY. Water Resources

Div. B. J. Schneider, and E. T. Oaksford. Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 84-4321, 1986. 46 p. 26 fig, 7 tab, 28 ref.

Descriptors: \*Artificial recharge, \*Reclaimed water, \*Long Island, \*New York, Groundwater, Injection wells, Unsaturated flow, Recharge facilities, Recharge effects.

ties, Recharge effects.

Artificial recharge with tertiary-treated sewage is being tested at East Meadow to evaluate the physical and chemical effects on the groundwater system. The recharge facility contains 11 recharge basins and 5 injection wells and is designed to accept 4 million gallons of reclaimed water per day. Of the 11 basins, 7 are recently constructed and will accept 0.5 million gallons per day each. An observation manhole (12-foot inside diameter and extending 16 feet below the basin floor) was installed in each of two basins to enable monitoring and sampling of percolating reclaimed water in the unsaturated zone with instruments such as tensiometers, gravity lysimeters, thermocouples, and soil-gas samplers. Five shallow (100-feet deep) injection wells will each return 0.5 million gallons per day to the groundwater reservoir. Three types soil-gas samplers. Five shallow (100-feet deep) injection wells will each return 0.5 million gallons per day to the groundwater reservoir. Three types of injection-well design are being tested; the differences are in the type of gravel pack around the well screen. When clogging at the well screen cocurs, redevelopment should restore the injection capability. Flow to the basins and wells is regulated by automatic flow controllers in which a desired flow rate is maintained by electronic sensors. Basins can also operate in a constant-head mode in which a specified head is maintained in the basin automatically. An observation-well network consisting of 2-inch- and 6-inch-diameter wells was installed within a 1-square-mille area at the recharge facility to monitor aquifer response and recharge. During 48 days of operation within a 17-week period (October 1982 through January 1983), 88.5 million gallons of reclaimed water was applied to the shallow water table aquifer through the recharge basins. A 4.29-foot-high groundwater mound developed during a 14-day test; some water level increase associated with the mound was detected 1,000 ft from the basins. Preliminary water quality data from wells affected by reclaimed water show evidence that mechanisms of mixing, dilution, and dispersion are affecting chemical concentrations of certain constituents, such as nitrogen and trichlorocthane, in the shallow aquifer beneath the recharge area. (USGS)

CONTROL AND TREATMENT OF RESIDUAL WATER IN MINING (CONTROL Y TRATA-MIENTO DE AGUAS RESIDUALES EN MIN-

ERIA), Empresa Nacional Adaro de Investigaciones Min-eras S.A., Madrid (Spain). For primary bibliographic entry see Field 5B. W87-09882.

PURIFICATION OF ACID DRAINAGE WATER IN THE MINE OF PICCALINNA (SARDINIA), AND THE RECOVERY OF THE SEPARATED METALS (L'EPURATION DES EAUX ACIDES D'EXHAURE DE LA MINE PICCALINA (SAR-DAIGNE) ET LA RECUPERATION DES METAUX SEPARES), Confire I libit (Heb.)

METAUX SEPARES), Cagliari Univ. (Italy). M. Ghiani, and E. Tonetti. IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol-umes I and II, 1984. SIAMOS 78. p 1049-1062, 6

Descriptors: \*Wastewater treatment, \*Water pollu-tion control, \*Acid mine drainage, \*Mine drainage, \*Mine wastes, Piccalina mine, Heavy metals, Metals, Precipitation, Sedimentation.

The most common methods of treatment in use today to solve the problem of water pollution

posed by acid pumping waters of certain metallic mines are reviewed. The possibility of purifying acid pumping waters from the Piccalina mine (Montevecchio) having an exceptionally high con-centration of heavy metal ions was examined. Re-lated experimental methods were presented. The technical possibility of purification is demonstrated by applying the well-known processes of precipita-tion and sedimentation of hydroxides, and adopting the following alternative flowshers: (1) single the following alternative flowsheets: (1) single stage treatment with the sole objective of complystage treatment with the sole objective of comply-ing with the severe limitations imposed by the provisions of Italian law regarding water pollution, and (2) multistage treatment with the additional aim of recovering one or more of the commercial products precipitated. (Author's abstract) W87-09889

FLUIDIZED BED ELECTROLYSIS FOR THE REMOVAL OR RECOVERY OF METALS FROM DILUTE SOLUTIONS, Akzo Zout Chemie Nederland B.V., Hengelo. G. van der Heiden, C. M. S. Raats, and H. F.

Boon.
IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volumes I and II, 1984. SIAMOS 78. p 1095-1109, 13

Descriptors: \*Fluidized bed process, \*Wastewater treatment, \*Electrolysis, \*Fluidized beds, \*Metals, Electrochemistry, Technology, Industrial wastewater, Cathodes, Electrodes, Mine drainage.

Akzo Zout Chemie has developed a new electroly-sis technology based on the fluidized bed principle. Because scaling-up problems were solved, the process is suitable for industrial application. Fea-tures of fluidized bed electrolysis (FBE) are a high specific cathode area and a high mass transfer rate due to turbulence created by the moving metal particles, which function as the cathode. There-fore, FBE is particularly suited for the selective recovery or removal of metals which are present in fore, FBE is particularly suited for the selective recovery or removal of metals which are present in low concentrations in large volume process streams. FBE can be applied both in solving wastewater problems (e.g. mine water) and in hy-drometallurgical processes. An important advan-tage of FBE over conventional techniques is the economic and simple one-step conversion of a dilute metal solution into a rather pure metal product. (Author's abstract) W87-09892

OXYGEN DIFFUSION AND MICROBIAL ACTIVITY IN THE COMPOSTING OF DEHY-

DRATED SEWAGE CAKES, Shizuoka Univ., Hamamatsu (Japan). Dept. of Chemical Engineering. For primary bibliographic entry see Field 5E. W87-09923

MICROBIAL CONVERSION OF DISTILLERY MASTE TO BIOENERGY: EFFECTS OF MEDIA ENRICHMENT WITH LOW CHAIN FATTY ACIDS AND CANDIDA SP., Skogshoegskolan, Umea (Sweden). R. Nandan, H. Chandra, S. K. Bhargava, and P. K.

Ray. Journal of Fermentation Technology JFTED8, Vol. 65, No. 1, p 49-60, February 1987. 2 fig, 6 tab,

Descriptors: \*Wastewater treatment, \*Biological wastewater treatment, \*Microbial degradation, \*Fatty acids, Biodegradation, Methanogenesis, Industrial wastes, Distillery wastes, Methane, Metha ane bacteria, Fermentation. Chemical oxygen

During microbial methanogenesis of diluted distillery waste or spent wash (initial COD 25,000 mg/l) in the presence of sodium acetate, sodium propionate, or sodium butyrate at the concentration of 2000 mg/l, biogas containing 22.0% to 39.4% methane was produced in 20 days in a semicontinuous fermentation system. The analysis of the volatile fatty acid spectrum of the effluent showed accumulation of 46.3% branched chain fatty acids. When the fermentation medium was supplemented

#### **Group 5D—Waste Treatment Processes**

with modified Smith and Mah (SM) medium con taining electrolytes and 1% sodium acetate, production of methane went up to 59.0% in 18 days. With the addition of a strain of Candida sp. the coculture produced about the same volume of methane (61%) but the time required was reduced methane (61%) but the time required was reduced to 14 days. COD (16600.8 mg/l) was reduced and the effluent contained only 3% branched chain fatty acids and 96% straight chain fatty acids. Fortification with sodium salts of three branchedchain fatty acids as sources of carbon in SM medium alone reduced methane production. Only 0.0% to 14.2% methane was recorded. By combining the production of the producti ing these acids with straight chain fatty acids in SM medium, methane production increased significantly (about 4-fold) in proportion to the concentration of straight chain fatty acids added. (Author's abstract) W87-09924

APPLYING BELT CONVEYING SYSTEMS IN

TREATMENT PLANTS,
Barrette (Oliver) Millwrights, Inc., Providence,

C. G. Craven. Water Engineering and Management WENMD2, Vol. 134, No. 2, p 30-31, February 1987.

Descriptors: \*Wastewater facilities, \*Belt conveying systems, \*Wastewater treatment, \*Design criteria, Design standards, Engineering, Sludge, Conveyor belts, Standards.

In spite of the advances in construction of wastewater treatment plants during the past fifteen years, the engineering standards in the design of belt conveying systems for handling dewatered sludge, grit, screenings and woodchips are not acceptable. Problems associated with improperly designed conveying belts were described. New designs and custom-engineered belt conveyors should be considered. When general contractors define the bid specifications, the application criteria and the types and minimum acceptable equipria and the types and minimum acceptable equip-ment standards should be given allowing the manufacturers to determine appropriate construction details. Successful applications of several types of conveyor designs were described. (Wood-PTT) W87-09938

COMPARISON OF BIOLOGICAL AND CHEMICAL PHOSPHORUS REMOVALS IN CONTINUOUS AND SEQUENCING BATCH REACTIONS OF THE PROPERTY OF THE TORS.

Notre Dame Univ., IN. Dept. of Civil Engineer-

H. Ketchum, R. L. Irvine, R. E. Breyfogle, and

J. F. Manning. Journal of the Water Pollution Control Federation JWPFA5, Vol. 59, No. 1, p 13-18, January 1987. 3 fig, 4 tab, 6 ref.

Descriptors: \*Nutrient removal, \*Phosphorus, \*Batch reactors, \*Wastewater treatment, \*Biological wastewater treatment, \*Chemical treatment, Technology, Wastewater, Municipal wastewater, Aerobic conditions, Anaerobic conditions, Nutrients, Alum, Chlorides, Polymers, Chemical analy-

A full-scale study of phosphorus removal was conducted at the Culver (IN) municipal water plant ducted at the Culver (1N) municipal water plant using continuous-flow operation, sequencing batch reactor (SBR) operation, and several different chemical treatment schemes. Four contributing groups of organisms and their roles in biological SBR P removal are described: dentiritying organisms formatistic products assured for the second contributions of the second contributions of the second contribution of the second contri SBR P removal are described: denitrifying orga-nisms, fermentation product, manufacturing orga-nisms, P-accumulating organisms, and aerobic au-totrophs and heterotrophs. It is concluded that the SBR can provide the proper balance of anoxic, anaerobic, and aerobic conditions to allow these groups of organisms to remove P biologically without chemical addition. Treatment results using various chemicals for P removal, both during con-ventional, continuous-flow operation and after the plant was converted for SBR operation, are also provided for comparison. Effluent P concentra-tions were almost identical for each period, except for the period when P was removed biologically for the period when P was removed biologically and without any chemical addition when effluent P

concentrations were the lowest. These removals were made as a result of settling alone; no tertiary rapid sand filter was used or required. (Dorin W87-09945

BIOLOGICAL ENHANCEMENT OF OXYGEN TRANSFER IN THE ACTIVATED SLUDGE PROCESS,

Virginia Polytechnic Inst. and State Univ., Blacks-

burg.
R. O. Mines, and J. H. Sherrard.
Journal of the Water Pollution Control Federation
JWPFAS, Vol. 59, No. 1, p 19-24, January 1987. 3
fig, 4 tab, 19 ref.

L'escriptors: "Activated sludge process, "Biologi-cal wastewater treatment, "Aeration, "Oxygen transfer, "Technology, "Wastewater tratter, Sludge, Activated sludge, Prediction, Interfaces, Adsorption, Kinetics, Wastewater, Oxidation, Model Studies. Descriptors: \*Activated sludge process, \*Biological wastewater treatment, \*Aeration, \*Oxygen

A laboratory investigation was undertaken to evaluate oxygen transfer in the completely mixed activated sludge process. The steady-state oxygen transfer coefficient determined in mixed liquor increased as mean cell residence time and oxygen uptake rate increased. This phenomenon was attributed to interfacial oxygen transfer, which provides an alternate pathway at high solids concenvides an alternate pathway at high solids concentrations and high oxygen uptake rates. Nonsteadystate reaeration tests conducted in tap water revealed that the oxygen transfer coefficient value for each reactor's diffused aeration system was constant and agrees with the two-film model. It is concluded that the two-film model must be modified. concluded that the two-film model must be modified to account for the oxygen uptake rate and interfacial oxygen transfer to reliably predict oxygen transfer rates in the completely mixed activated sludge process. (Author's abstract) W57-09946

DEVELOPMENT OF A RATIONALLY BASED DESIGN PROTOCOL FOR THE ULTRAVIOLET LIGHT DISINFECTION PROCESS,

Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div. O. K. Scheible. Journal of the Water Pollution Control Federation JWFFA5, Vol. 59, No. 1, p 25-31, January 1987. 6 fig. 2 tab, 9 ref. EPA Cooperative agreement CR 87356.

Descriptors: \*Wastewater treatment, \*Disinfection, \*Ultraviolet radiation, \*Model studies, \*Mathematical studies, Radiation, Flow, Bacteria, Calibrations, Hydraulics, Particulate matter, Regression analysis, Photometry, Spectrophotometry, Light intensity, Kinetics.

A protocol is demonstrated for the design and evaluation of ultraviolet disinfection systems that address the key UV process elements. The mathematical model incorporates the dimensional configuration of the system, the UV intensity, the dispersion and residence time distribution (RTD) characteristics of the reactor, and the key water quality parameters. The modelling approach is generic and can be used to characterize most reactor configurations and wastewater conditions. Once the model has been calibrated, any number of design configurations and calibrated, any number of design configurations. tions and wastewater conditions. Once the model has been calibrated, any number of design configurations can be evaluated, and sensitivity analyses can be performed to test the effects of specific parameters. It is concluded that the ideal hydraulic design of a UV reactor is one with plug flow and minimal axial dispersion. The average intensity of UV radiation in a reactor can be estimated by the point source summation calculation method, and can be described as a function of the absorbence coefficient of the wastewater. Continued efforts should be encouraged to develop further experience in the application of the proposed protocol to full-scale designs and the evaluation of current systems. (Doria-PTT) W87-09947

WET AIR OXIDATION OF ANAEROBICALLY DIGESTED SLUDGE, New Jersey Inst. of Tech., Newark. Dept. of Civil

and Environmental Engineering. Y. C. Wu, O. J. Hao, D. G. Olmstead, K. P. Hsieh, and R. J. Scholze.

Journal of the Water Pollution Control Federation

JWPFA5, Vol. 59, No. 1, p 39-46, January 1987. 13 fig. 3 tab, 28 ref. Army Construction Engineering Research Laboratory/EPA/Allegheny County Sanitary Authority Grant DW-930244.

Descriptors: \*Oxidation, \*Sludge digestion, \*Sludge disposal, \*Cost analysis, \*Performance evaluation, \*Wastewater treatment, \*Optimization, Biodegradation, Digestion, Sludge cake, Temperature, Temperature effects, Sample preparation, Wastewater analysis, Chemical analysis, Chemical properties, Sludge, Organic matter, Effluents, Solids, Alkalinity, Acids, Organic acids, Heavy metals, Sedimentation.

The effects of the wet air oxidation (WAO) proc-The effects of the wet air oxidation (WAO) proc-ess were examined on digested sludge, using either digested sludge or a concentrated sludge cake as the feed under various digestion conditions. Tem-perature was the most significant process parame-ter. At about 14.5 kPa, sludge destruction occurred primarily at temperatures > 180 C and increased with temperature. The WAO treatment reached with temperature. The WAO treatment reached maximum efficacy of approximately 86% volatile solids reduction at 275 C or higher. The ability of the WAO process to destroy anaerobically digested sludges did not vary among sludge types. The WAO process converted much off insoluble organic matter to short-chain organic acids, ammonia, nitrate, nitrite, organic nitrogen, and carbon dioxide. Settling characteristics of WAO effluent solids improved. With increasing temperatures, sludgeite matter to short-cann organic acids, ammona, mitrate, nitrite, organic nitrogen, and carbon dioxide. Settling characteristics of WAO effluent solids improved. With increasing temperatures, sludge volume index values (18 mg/l or less) were possible. Among metals studied, only soluble Cu concentration was found in appreciable quantity in the WAO effluent; all other metals were associated with the WAO residue. Metal stabilization might be required for final disposal of the WAO ash. The WAO effluent contained high nutrient concentrations. For plants with nutrient deficiencies, recycling of nitrogen-rich WAO supernatant might be a useful method to supplement nutrients. The WAO effluent that contains mainly acetic acid may be recycled to the sludge digestion process. (Doria-PTT) W87-09949

SOLVENT REGENERATION OF DYE-LADEN

ACTIVATED CARBON, R.J. Posey, and B. R. Kim. Journal of the Water Pollution Control Federation JWPFA5, Vol. 59, No. 1, p 47-53, January 1987. 7 fig, 5 tab, 14 ref.

Descriptors: \*Solvents, \*Methanol, \*Activated carbon, \*Dyes, \*Regeneration, \*Wastewater treat-Descriptors: "Solvents, "Methanot, "Activated carbon, "Dyes, "Regeneration, "Wastewater treatment, "Cost-benefit analysis, Carbon, Adsorbents, Organoleptic properties, Color, Effluents, Adsorption, Isotherms, Economic aspects.

A study was performed to evaluate the efficiency of extracting three organic dyes and p-chlorophenol from an exhausted activated carbon using methanol, and to assess the economic feasibility of solvent regeneration. For three of the compounds studied, solvent regeneration was not cost competitive with thermal regeneration because of the loss of adsorption capacity, which requires frequent regenerations, the large amount of methanol used, and the excessive cost of methanol makeup. Solvent regeneration was feasible for PCP, with approximately 100% restoration of virgin capacity. For the dye compounds SY, DY, and DR, with some impurities, loss of adsorption capacity occurred after regeneration, possibly caused by some irreversible adsorption of the dye compounds and competition between the dyes and impurities. Virtually all loss of capacity (irreversible adsorption) occurred during the first exhaustion/desorption cycle. (Doria-PTT)

SIDESTREAMS IN WASTEWATER TREAT-MENT PLANTS,

Environmental Protection Agency, Cincinnati, OH. Water Engineering Research Lab.

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Journal of the Water Pollution Control Federation JWPFA5, Vol. 59, No. 1, p 54-59, January 1987. 1 fig, 3 tab, 7 ref. EPA Contracts 68-03-3019 and 68-03-3208.

Descriptors: \*Sidestreams, \*Wastewater treatment, \*Wastewater facilities, \*Recycling, \*Mass transfer, Sludge conditioning, Filtration, Screens, Drying, Sludge drying.

Sludge drying.

Performance problems at water treatment facilities are often attributed to the recycling of sidestreams generated in the wastewater treatment and sludge handling facilities. The following points are considered to minimize sidestream impacts on mainstream and solids treatment processes. Adverse stream impacts can be minimized through development of mass balances during design that incorporate recycle flows and loads, provide for alternate recycle points, and consider separate treatment for problem sidestreams. Adverse impacts in existing plants can be mitigated by changing the point of recycle, timing, and return rate; implementation of other operational procedures; and separate treatment for problem sidestreams. During planning and design, sidestream flows and loads should be characterized and mass balances developed to describe anticipated requirements. Process design data, equipment sizing, and points of recycle should be established based on results of the balances with provisions for peak loads and equipment flexibility. (Doria-PTT) W87-09951

TREATMENT OF SLAUGHTERHOUSE WASTEWATER USING FLUIDIZED BED BIOFILM REACTORS, National Cheng Kung Univ., Tainan (Taiwan). Dept. of Environmental Engineering. C. T. Li, W. K. Shieh, C. S. Wu, and J. S. Huang. Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 1-10, 1987. 6 fig, 2 tab, 14 ref.

Descriptors: \*Biofilm, \*Food-processing wastes, \*Slaughterhouses, \*Anaerobic digestion, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Reactors, Biomass, Oxida-

The oxygenic fluidized bed biofilm reactor (FBBR) was evaluated in a laboratory investigation for treatment of pig slaughtering wastewater (slaughterhouse wastewater). Because the slaughislaughterhouse wastewater). Because the slaughterhouse wastewater contains a high concentration of grease, chemical coagulation/floculation was adopted as the pretreatment step prior to FBBR was revaluated at BOD loadings of between 8.5 to 98.5 kg/cu m/day, hydraulic retention times of between 8.8 to 30.8 minutes, recirculation ratios of between 1 to 6, and feed BOD concentrations of between 1 to 6, and feed BOD concentrations of between 1 to 60 mg/L. Under these operating conditions, removal efficiencies of BOD, grease, and NH3-N were in the range of 71 to 94%, 29 to 84%, and 20 to 73%, respectively. Both BOD and grease of the slaughterhouse wastewater used could be lowered to 40 and 10 mg/L, respectively, at a BOD loading of 20 kg/cu m/day in order of meet effluent requirements to be enforced in Taiwan in 1990. Because the maximum amount of oxygen 1990. Because the maximum amount of oxygen that could be dissolved in the oxygenation device that could be dissolved in the oxygenation device used in this investigation was 40 mg/L, the FBBR would become anaerobic when the BOD loading applied exceeded 30 kg/cu m/day. Relatively constant biomass holdups (10,000 mg TVS/L) could be maintained in FBBRs over the BOD loadings applied via the practice of regular biofilm separation and biomass wasting. The combined chemical coagulation/flocculation-FBBR process provides a feasible and cost-effective alternative for treatment feasible and cost-effective alternative for treatment of a slaughterhouse wastewater. (Author's abstract) W87-10044

HIGH LOAD PROCESS USING YEASTS FOR VINASSES OF BEET MOLASSES TREAT-MENT.

Centre de Recherche Lyonnaise des Eaux - Degre-

mont, Le Pecq (France).
D. Malnou, A. Huyard, and G. M. Faup.
Water Science and Technology WSTED4, Vol.
19, No. 1/2, p 11-21, 1987. 2 fig, 3 tab, 13 ref.

Descriptors: \*Vinasse, \*Yeasts, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Sugars, Biomass.

Bulky plants are required to treat industrial effluents using conventional processes (settlement tanks, activated sludge, etc.). New techniques are being sought to reduce the size of the plants. The use of microorganisms, such as yeasts, in aerated reactors makes it possible to process effluents with very high volumetric loads and to produce a valorizable biomass. Despite their high salinity and COD connentration, yeasts can be used to process sugarbeet molasses liquors with volumetric load exceeding 80 kg COD/cu m/d, removing 70% of the COD. The improvement in the quality of the biomass produced and the design of new types of reactor will allow this high-performance process to be developed into an interesting alternative method of treating concentrated industrial effluents. (Author's abstract) thor's abstract) W87-10045

TREATABILITY STUDIES OF PALM OIL RE-FINERY WASTEWATERS, National Univ. of Singapore. Dept. of Civil Engi-

neering. K. K. Chin, W. J. Ng, A. N. Ma, and K. K. Wong. Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 23-29, 1987. 6 fig, 2 tab, 2 ref.

Descriptors: \*Palm oil, \*Food-processing wastes, \*Air flotation, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Reactors, Pollution load.

Wastewaters from palm oil refineries were treated using physical-chemical and biological treatment systems. Dissolved air floatation (DAF) after chemical coagulation flocculation with lime, alum, systems. Dissolved air floatation (DAF) after chemical coagulation floculation with lime, alum, and polyelectrolyte removed more than 90% of the influent COD, suspended solids, and oil and grease. Laboratory data compared closely with pilot and full scale plant operating data. Pretreated wastewaters from physical and chemical refining were further treated with the sequencing batch reactors (SBRs). The SBRs allow the control of reaction time and the maintenance of biological solids to be accomplished in a single tank. Laboratory and pilot scale studies showed a high degree of BOD and COD removal efficiencies. Microprocessor-based timers were used to control the operating modes. The cycle times used varied from 8 to 24 hours. The process showed stability under wide variations of organic strength (300 to 2500 mg/ BOD) and loading rates (6.4 to 2.0 mg/ COD/mg MLVSS). (Author's abstract)

QUANTIFICATION OF ODOUR PROBLEMS ASSOCIATED WITH LIQUID AND SOLID FEEDLOT AND POULTRY WASTES, National Inst. for Water Research, Bellville (South Africa). Cape Regional Lab. For primary bibliographic entry see Field 5A. W87-10047

TREATMENT OF WASTEWATERS FROM THE TOMATO CONCENTRATE INDUSTRY IN TOMATO CONCENTRATE HIGH RATE ALGAL PONDS,

ALIGAL FUNDS, National Inst. for Water Research, Bellville (South Africa). Cape Regional Lab. A. M. Rodrigues, and J. F. S. Oliveira. Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 43-49, 1987. 6 tab, 19 ref.

Descriptors: \*Tomatoes, \*Food-processing wastes, \*Algal ponds, \*Biological wastewater treatment, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Biomass.

High rate algal ponds are an important process of biological treatment used either for domestic sewage or food industries effluents and to produce single cell proteins. The results refer to the effi-ciency of treatment of wastewaters from the tomato concentrate industry and determination of the chemical composition of 'Albazod' (microbial biomass) harvested in a pilot system of high rate algal ponds installed in the Department of Envi-

ronmental Engineering, Faculty of Sciences and Technology, New University of Lisbon, at Monte da Caparica. Depending on the detention time and period of the year, the following removal efficiencies were obtained: COD 68.1-94.6%; TOD 57.6-85.0%; N-NH4(+) 89.4-96.2%; color 29.6-91.7% and turbidity 37.2-92.7%. Albazod separated from the effluent has a high nutritive value for low detention times (crude protein values of 31.50% and 30.75% dry matter for 4 days and 5 days of detention time, respectively). The highest productivity value was 30.82 g of dry matter/sq m/day and was obtained for a detention time of 4 days. (Author's abstract)

DEVELOPMENT OF ECOLOGICAL WASTEWATER TREATMENT AND UTILIZATION SYSTEMS (EWTUS) CHINA, Harbin Civil Engineering Inst. (China). Water Pollution Control Lab.
W. Baozhen.

Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 51-63, 1987, 10 fig. 2 tab.

Descriptors: \*China, \*Bacteria, \*EWTUS
\*Wastewater treatment, Wastewater, Stabilization
ponds, Industrial wastewater.

Experience and practice of the treatment and utilization of sewage and organic wastewaters using stabilization ponds with artificial or semi-artificial ecosystems in China are described. The eco-ponds being used in China are different from those with symbiotic algae/bacteria systems in that the former symbiotic algae/bacteria systems in that the former consist of not only bacteria and fungi as decomconsist of not only bacteria and fungi as decomposers and algae as producers, but also fish, shrimps, shellfish, ducks, geese, etc. These are consumers at different trophic levels in food chains or food webs in the pond communities where fish farming and/or duck and geese raising takes place. The eco-ponds are characterized by low capital and operation costs, energy savings, high removal efficiencies for a wide variety of pollutants, and considerable profits that can be gained from comprehensive utilization of wastewaters as recoverprehensive utilization of wastewaters as recover-able resources. Some typical eco-ponds for treat-ment and utilization of municipal and industrial wastewaters, such as fish farming ponds in Chang-sha, (Hunan), and in Ehcheng, (Hubei), hydro-phyte ponds in Shaoxing, (Jejiang) and in Shijiaz-huand, (Hebei), and treatment/storage lagoons with ecosystems are described in detail. The con-cept of ecological systems for treatment and utili-pation of westewaters and the various ecological cept of ecological systems for treatment and utilization of wastewaters, and the various ecological wastewater treatment and utilization systems (EWTUS) available for different regions, are also discussed in this paper. (Author's abstract) W87-10049

PERFORMANCE OF AERATED LAGOONS IN TREATING WASTEWATER FROM SMALL COMMUNITIES,

Sherbrooke Univ. (Quebec). Dept. of Civil Engi-R. S. Narasiah, C. Morasse, and M. Larue. K. S. Narasiah, C. Morasse, and M. Larue. Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 65-76, 1987. 5 fig, 4 tab, 11 ref.

Descriptors: \*Aerated lagoons, \*Biological wastewater treatment, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents,

Aerated lagoons are used in developing and developed countries to treat domestic and industrial wastewater especially from small communities. They represent a reliable method of biological treatment capable of producing satisfactory effluent themselves the control of the cont treatment capable of producing satisfactory effluent throughout the year. They are preferred to several other treatment processes like the activated sludge because of the simplicity of the overall system, less need for trained operator assistance and very competitive overall cost of wastewater treatment. In Quebec where there are some 1400 small municipalities this method of treatment is found to perform satisfactorily, notwithstanding the extreme temperature variations. The objective of the present study is to evaluate the performance of this method of waste stabilization from the point of view of organic removal, retenion time, power view of organic removal, retention time, p

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requirement and nutrient removal without chemi cal coagulation. An existing treatment plant with aerated lagoons was used for the study. The results show that a summer retention time of about 8 days can produce an effluent having 20-25 mg/L of BOD, 20 mg/L of SS and 2-3 mg/L of total phosphates without coagulant addition. (Author's abstract)
W87-10050

STUDY OF UPGRADING WASTE STABILIZA-

TION PONDS, University of the West Indies, St. Augustine (Trinidad and Tobago). Dept. of Civil Engineering. P. R. Thomas, and H. O. Phelps. Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 77-83, 1987. 5 fig, 2 tab, 6 ref.

Descriptors: \*Upgrading, \*Stabilization ponds, \*Domestic wastewater, \*Wastewater treatment, Bacteria, Water hyacinth, Effluents, Performance

A study was carried out in one of the two facultative stabilization ponds operating in parallel and receiving domestic sewage in excess of their capacities. Effluent quality from the pond was monitored in terms of the parameters total suspended solids, biochemical oxygen demand, pH, dissolved oxygen and fecal coliform bacteria before and after the introduction of water hyacinths. No significant improvement in effluent quality was observed after the introduction of the water hyacinths. High loading on the pond did not permit to upgrade the effluent quality to acceptable standards by the use of water hyacinths. Although the research is continuing some results and recommendations are given. (Author's abstract) W87-10051

WASTEWATER TREATMENT FOR INDUSTRI-AL ESTATES IN SOUTHEAST ASIA USING WATER HYACINTHS,

WAIER HYACINTHS, Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering. H. Orth, K. Lertpocasombut, and P. A. Wilderer. Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 85-96, 1987. 4 fig, 7 tab, 14 ref.

Descriptors: \*Southeast Asia, \*Water hyacinth, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Bacteria, Biofilm.

Pilot scale experiments were conducted to examine the applicability of water hyacinth systems for the treatment of raw wastewater discharged by small factories and housing areas of an industrial estate. Results obtained are encouraging, and justify the Results obtained are encouraging, and justify the idea of starting wastewater treatment in the early phase of an estate's development with aquatic plant treatment systems which later can be further employed for advanced treatment. Although sludge accumulated extensively in the inlet zone of the plug-flow system, and oxygen was deficient in the bulk of the liquid, BOD and COD dropped to a level satisfying secondary treatment standards. Nibulk of the inquid, BOD and COD dropped to a level satisfying secondary treatment standards. Ni-trogen was eliminated to a great extent suggesting that nitrification was occurring, presumably at the root surface, and denitrification in the outer oxygen deficient zones. Batch experiments demonstrated that the plants were able to satisfy the oxygen demand of both heterotrophic bacteria and nitrifiers forming the root supported biofilm. (Author's abstract) W87-10052

ROLE OF THE OPERATION REGIME IN WASTEWATER TREATMENT WITH DUCK-

WASIEWAIER IREGISHED THE WEED,
Ben-Gurion Univ. of the Negrv, Sde Boker (Israel). Jacob Blaustein Inst. for Desert Research.
G. Oron, A. de-Vegt, and D. Porath.
Water Science and Technology WSTED4, Vol.
19, No. 1/2, p 97-105, 1987. 3 fig, 5 tab, 19 ref.

Descriptors: \*Duckweed, \*Biomass, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Retention ponds.

The results of outdoor experiments with Lemna gibba (a duckweed species) grown in mini-ponds

proved to be highly competitive in comparison with other existing secondary treatment methods. The treated wastewater is at an acceptable level and can be reused for agricultural irrigation. The and can be reused for agricultural irrigation. The duckweed biomass, with a crude protein content of over 30% of dry weight, may be used as a protein rich alternative fodder. The ease of duckweed harvesting makes the potential treatment system even more economically attractive. Operational regime was controlled by the retention time and wastes depth. Retention time was in the range of 3 to 10 days, while the depths examined were 20 cm and 30 cm. The results indicate that shortening the retention time was associated with increase in protein content and did not affect the yield year. tein content and did not affect the yield very much. The duckweed yield (dry basis) in the deep ponds (30 cm) was very similar to the 20 cm ponds, viz. around 14 g/sq m per day. (Author's

TREATMENT OF WASTEWATER IN THE RHIZOSPHERE OF WETLAND PLANTS - THE ROOT-ZONE METHOD.

Aarhus Univ. (Denmark). Botanical Inst

Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 107-118, 1987. 5 fig, 2 tab, 29 ref.

Descriptors: \*Wetlands, \*Root zone method, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Nutrients, Nitrogen.

The theoretical basis of wastewater treatment in The theoretical basis of wastewater treatment in the rhizosphere of wetland plants, the so-called 'root-zone method,' along with the first working experiences from eight treatment plants in Den-mark is described. Mechanically treated wastewater is led horizontally through the rhizos-there of pushed plants. Duri which the coff the wastewater is led horizontally through the rhizos-phere of wetland plants. During the passage of the wastewater through the rhizosphere, the wastewater is cleaned by microbiological degrada-tion and by physical/chemical processes. The wet-land plants supply oxygen to the heterotrophic microorganisms in the rhizosphere and stabilize the hydraulic conductivity of the soil. Nitrogen is re-moved by denitrification and phosphorus and heavy metals are bound in the soil. The first work-ing experiences from Demarks how, that as for seing experiences from Denmark show, that as far as BOD is concerned root-zone treatment plants are very nearly up to conventional secondary treat-ment standards already from the first growing season (removal efficiency: 51-95%). For the nutrients nitrogen and phosphorus the results vary (total-N removal: 10-88%; total-P removal: 11-94%). The removal efficiencies depended mainly on the composition of the soils and the degree of surface runoff in each treatment plant. It is con-cluded that root-zone treatment plants seem to be a viable alternative to conventional wastewater treatment technology, especially suitable for single households and small to medium sized communi-ties. There is, however, still very little information on the removal processes for nitrogen (denitrifica-tion), on the effect of soil type and on the required surface area to load ratio. (Author's abstract) W87-10054

STUDIES OF UPTAKE AND TOXIC EFFECTS OF CR(VI) ON PISTIA STRATIOTES, Visva-Bharati Univ., Santiniketan (India). Dept. of

Chemistry. For primary bibliographic entry see Field 5B. W87-10055

ABILITY OF LETTUCE, RYE GRASS AND BARLEY TO REDUCE THE NUTRIENT SALT CONTENT OF WASTEWATER FROM FISH

Danmarks Ingenioerakademi, Lyngby. B. W. Pettersen.

Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 129-138, 1987. 10 fig, 5 tab, 13 ref.

Descriptors: \*Fisheries, \*Biological wastewater treatment, \*Wastewater treatment, \*Impaired water use, Nutrients, Salts, Aquaculture.

In order to find methods to reduce the nutrient salt content of waste water from aquaculture systems,

crop and field plants such as lettuce, rye grass and barley were cultivated in water coming from a pilot size fish farming unit for rainbow trout. Growth rates for rye grass and barley were less Growth rates for rye grass and barley were less than 50% of the maximum growth rates obtained under field conditions in Denmark, and lettuce could not grow in the recirculating water. By adding carbon dioxide to the recirculating water until slightly above the equilibrium concentration, growth rates for rye grass and barley improved to maximum rates under field conditions, and lettuce of good quality was produced. Mass balances for P and N indicate that fertilizing value of wastewater from 25 kg rainbow trout is sufficient for cultivation of 20 sq m rye grass at maximum growth rate. (Author's abstract)

DESIGN CONSIDERATIONS FOR A NITRIFICATION-DENITRIFICATION PROCESS USING TWO FIXED-BED REACTORS IN SERIES,

Lyonnaise des Eaux, Le Pecq (France). Lab. Cen-

B. Jimenez, B. Capdeville, H. Rogues, and G. M.

Faup.
Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 139-150, 1987. 9 fig, 4 tab, 13 ref.

Descriptors: \*Design criteria, \*Nitrification, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Cultures, Reactors, Nitro-

sign considerations (kinetics and hydraulic cri-Design considerations (kinetics and hydraulic criteria) for a biological nitrification-dentirification attached culture process for sewage treatment are described. The treatment system is composed of two submerged filters. The first one, an anoxic reactor, denitrifies and retains wastewater suspended solids. The second one oxidized organic carbon and ammonia nitrogen. It was found that the main parameter for the system is the recycle ratio since parameter for the system is the recycle ratio since it sets the real hydraulic detention time in reactors and determines the quantity of nitrogen available to the denitrification process. (Author's abstract)

PROCESS ANALYSIS OF FLUIDIZED BED BIOFILM REACTOR FOR DENITRIFICA-TION,

nological Univ. of Nagaoka (Japan). Dept. of

Civil Engineering.
H. Harada, H. Ando, and K. Momonoi.
Water Science and Technology WSTED4, Vol.
19, No. 1/2, p 151-162, 1987. 14 fig, 1 tab, 14 ref.

Descriptors: \*Model studies, \*Denitrification, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Biofilm, Kinetics, Simula-

A mathematical model is proposed herein to de-scribe the dynamic behavior of the denitrification process in a fluidized bed biofilm reactor. The model basically consists of the following four sub-models: bioparticles fluidization, bulk liquid flow pattern, substrate conversion within biofilm and biofilm thickness development. As for intrinsic denitrification reaction, a consecutive two-step re-script kinetics with strike as an intermediate preaction kinetics with nitrite as an intermediate prod-uct is adopted. All parameters needed for simula-tion were experimentally determined. Verification of the model was obtained in a dynamic state using a laboratory-scale fluidized bed denitrification re-actor under well defined conditions. (Author's abstract) W87-10058

HIGH-RATE DENITRIFICATION OF CONCENTRATED NITRATE WASTEWATER,

Ruhrverband, Essen (Germany, F.R.). H. Bode, C. F. Seyfried, and A. Kraft. Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 163-174, 1987. 11 fig, 4 tab, 11 ref.

Descriptors: \*Denitrification, \*Activated sludge, \*Nitrates, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Bacteria, Re-

#### Waste Treatment Processes—Group 5D

The principles of high-rate denitrification are ex-The principles of high-rate denitrification are ex-plained. The results of nine lab-scale experiments are described and compared with data gained from reviewed literature. The tests were performed in continuous flow stirred-tank and wash-out reactors under mesophilic and thermophilic conditions. The experimental results confirm that high-rate denitrification is an extremely efficient process. Removal rates of up to 25 kg NOx - N sub el/cu m/d were rates of up to 25 kg NOx - N sub el/cu m/d were achieved with the activated sludge systems. The nitrate sludge loading was found to be the significant design parameter for the process if there is an excess of organic substrate. The maximum rate achieved by thermophilic bacteria was 10 kg NOx - N sub el/kg MLVSS/d which exceeded by 33% that for mesophilic organisms. Due to this, in the wash-out reactors the thermophilic system was superior to the mesophilic at system-related, inevitably similar MLVSS concentrations. But because of a temperature-dependent type of growth (thermophilic signers; mesophilic: flocculating), in the case of systems with recycling of biomass, higher removal rates (per volume) were obtained for the mesophilic reactors. (Author's abstract) W87-10059

NITRIFICATION AND AUTOTROPHIC DENI-TRIFICATION IN CALCIUM ALGINATE

my of Sciences, Zabrze. Inst. of Envi-

romental Engineering.

Z. Lewandowski, R. Bakke, and W. G. Characklis.

Water Science and Technology WSTED4, Vol.

19, No. 1/2, p 175-182, 1987. 9 fig, 6 ref.

Descriptors: \*Denitrification, \*Calcium alginate, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Bacteria, Ions.

Immobilization of nitrifiers and autotrophic denitri-Immobilization of nitrifiers and autotrophic denitri-fiers (Thiobacillus denitrificans) within calcium al-ginate gel was demonstrated. Calcium carbonate reagent was immobilized along with bacteria as the stabilizing agent. Protons released as a result of microbial respiration reacted with calcium carbon-ate producing calcium ions which internally stabi-lized the calcium alginate gel. The microbially active gel beads were mechanically stable and active for three months in a continuous flow system without addition of calcium. (Author's ab-stract) stract) W87-10060

INTERACTIONS BETWEEN PHOSPHATE, NI-TRATE AND ORGANIC SUBSTRATE IN BIO-LOGICAL NUTRIENT REMOVAL PROCESS-

National Inst. for Water Research, Pretoria (South

Alrica).
A. Gerber, E. S. Mostert, C. T. Winter, and R. H. de Villiers.
Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 183-194, 1987. 9 fig. 16 ref.

Descriptors: \*Phosphates, \*Nitrates, \*Activated sludge, \*Organic compounds, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Nutrients, Sludge.

The response of activated sludge following exposure to various organic compounds is described. Batch systems simulating the various stages of biological nutrient removal processes were used to study the dependence of phosphate release, enhanced phosphate uptake and denitrification on the nature and level of organic substrate, and the presence or absence of nitrate. The phenomenon of phosphate release is shown to be controlled primarily by the nature of the substrate rather than the creation of an anaerobic state. Certain short-chain fatty acids or their salts, such as acetate and propionate, induce phosphate release even under anoxic or aerobic conditions but with compounds such as ethanol and glucose release occurs only after the onset of anerobiiosis. Given the necessary conditions, the time course of phosphate concentration in initially anoxic mixtures of phosphate-rich sludge and short-chain fatty acids is shown to proceed in three consecutive stages, comprising primary release, anoxic uptake and secondary release respectively. It is concluded that phosphate

uptake and release occur simultaneously in the presence of fatty acids, which also render the best overall phosphate removal during aeration. (Author's abstract) W87-10061

BENEFITS OF INCLUDING UNAERATED ZONES IN NITRIFYING ACTIVATED SLUDGE

Cape Town Univ. (South Africa). Dept. of Chemical Engineering.
P. L. Dold, and G. R. Marais.

Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 195-207, 1987. 9 fig, 6 tab, 7 ref.

Descriptors: \*Activated sludge, \*Nitrification, \*Anoxic zone, \*Model studies, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Oxygen.

In nitrifying activated sludge systems several practical advantages accrue from inclusion of unaerated (anoxic) zones. Accepting the general activated sludge model proposed by the IAWPRC Task Group, simulation studies on nitrifying and nitrifying-denitrifying systems demonstrate the advantages of the latter with respect to (1) reduction in daily oxygen requirements, (2) reduction in effluent nitrate load, (3) elimination of pH control, (4) alleviation of the stringency in D.O. control, and (5) reduction in the required peak aeration capacity. (Author's abstract)

NITROGEN REMOVAL IN AN OXIDATION DITCH WITH INTERMITTENT AERATION, Saga Univ. (Japan). Dept. of Civil Engineering. K. Inomae, H. Araki, K. Koga, Y. Awaya, and T.

Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 209-218, 1987. 14 fig, 5 tab, 9 ref.

Descriptors: \*Aeration, \*Nitrogen removal, \*Oxion, \*Wastewater treatment, \*Industrewater, Wastewater, Effluents, Simulation.

wastewater, Wastewater, Effluents, Simulation. The typical process of nitrogen removal in the oxidation ditch is achieved through the control of oxygen supply (forming aerobic and anoxic zones within the ditch channel) or alternating aeration using intermittently operating aerator(s). The operating conditions for efficient nitrogen removal with any of these methods have yet to be clarified. An oxidation ditch system with a high rate of nitrogen removal characteristics were studied by experiments with a bench scale- and full scale-plant and by simulation. The conditions of optimum operation (aerobic and anoxic periods) for a high rate of nitrogen removal were found. These conditions principally depend upon the rates of nitrification and denitrification. By operating the full scale plant system with intermittent aeration (cycle time is 45 minutes and aerobic ratio is 0.42), a high rate nitrogen removal efficiency of 81% was achieved without adding any alkaline matter or organic carbon sources. It was shown that the results of simulation agree with the observed data of the full scale plant system, and that the rate of denitrification depends upon the conditions of intermittent aeration, (Author's abstract)

W87-10063

INHIBITION OF ANAEROBIC DEGRADA-TION OF PHENOLICS AND METHANOGENE-SIS BY COAL COKING WASTEWATER,

Alberta Univ., Edmonton. Dept. of Microbiology. P. M. Fedorak, and S. E. Hrudey. Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 219-228, 1987. 5 fig. 2 tab, 17 ref.

Descriptors: \*Anaerobic digestion, \*Phenols, treatment, \*Industrial wastewater, Wastewater, Effluents, Cultures, Methane bacteria.

Dilutions of a wastewater containing 410 mg/L phenolics (by 4-aminoantipyrine method) from a coal coking process were tested in anaerobic batch cultures to determine whether phenol degradation and subsequent methane production would occur.

Phenol was degraded in cultures which contained  $\langle \text{ or } = 30\% \text{ (V/V)}$  wastewater but no methane production could be attributed to the phenol degraded. radation. Higher concentrations of the wastewater severely inhibited methane formation likely due to cyanide which was present in the wastewater at 8.3 mg/L. Exhaustive extraction at neutral pH with diethyl ether could not alleviate this inhibition. dethyl ether could not alleviate this inhibition, suggesting that it was not primarily due to non-polar organic compounds. Although the inclusion of 2500 mg/L activated carbon in the batch cul-tures improved the methanogenic fermentation, methane yields were still lower than expected for complete phenolic conversion. (Author's abstract) W87-10064

ANAEROBIC TREATMENT OF COAL GASIFI-CATION WASTEWATER.

Illinois Univ. at Urbana-Champaign. Dept. of Civil

Engineering.

M. T. Suidan, P. Fox, and J. T. Pfeffer.

Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 229-236, 1987. 4 fig, 2 tab, 11 ref. DOE Grant DE-AC21-82MC19352.

Descriptors: \*Anaerobic digestion, \*Coal gasifica-tion, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Cultures, Ad-

A sequence of unit processes consisting of a berlsaddle-packed anaerobic filter, an expanded-bed, granular activated carbon anaerobic reactor and an activated sludge nitrification system was employed for the treatment of synthetically prepared coal for the treatment of synthetically prepared coal gasification wastewater. After acclimation, the coal gasification wastewater was fed to the treatment process train at three different chemical oxygen demand levels; these were 1,513,3,027, and 7,567 mg/L, respectively. No biological activity was observed in the first-stage filter, while excellent removal of organic matter was achieved in the second and third stages of the treatment system. However, toxicity to the anaerobic culture in the second stage reactor was observed during the second and third loading levels. This toxicity was overcome by employing a partial replacement second and third loading levels. This toxicity was overcome by employing a partial replacement schedule of the granular activated carbon medium in the reactor. This study represents an example of how biodegradation and physical adsorption may be successfully combined during the treatment of wastewaters containing toxic or inhibitory substances. (Author's abstract) W87-10065

ANAEROBIC TREATMENT OF AN APPLE PROCESSING WASTEWATER,

Cape Town Univ. (South Africa). Dept. of Chemi-

cal Engineering.
P. L. Dold, A. Sam-Soon, I. H. Palmer, and G. R.

Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 237-247, 1987. 8 fig, 4 tab, 10 ref.

Descriptors: \*Anaerobic digestion, \*Food-processing wastes, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Sludge, Per-

The new generation of anaerobic digestion systems provide a high level of performance under optimal conditions (37%). However, in practice many influents will be at lower temperatures - heating of digesters presents problems, particularly in developing countries where technical backup is limited. A study of the treatment of a low/medium A study of the treatment of a low/medium strength apple juicing waste in an upflow anaerobic sludge blanket reactor (UASB) at temperatures less than optimal (25 C and 30 C) is reported. Maximum loading rates of approximately 12 and 16 kg COD/cu m/d were attained at 25 C and 30 C, respectively, for influent concentrations in the range 2500 to 5000 mg COD/L. The comparative treatment capacity is in accord with the reported temperature sensitivity of mesophilic anaerobic processes. Formation of pelletized (granular) sludge enabled high upflow velocities and low sludge enabled high upflow velocities and low hydraulic retention times. (Author's abstract) W87-10066

#### **Group 5D—Waste Treatment Processes**

EFFECT OF CALCIUM ON MICROBIAL AGGREGATION DURING UASB REACTOR

GREGATION START-UP,
University of Western Ontario, London.
E. M. Mahoney, L. K. Varangu, W. L. Cairns, N.
Kosaric, and R. G. E. Murray.
Water Science and Technology WSTED4, Vol.
19, No. 1/2, p 249-260, 1987. 9 fig. 2 tab, 17 ref.

Descriptors: \*Activated sludge, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Eftreatment, \*Industrial wa fluents, Reactors, Calcius

The dynamics of granule formation were studied using cells from two bench-scale UASB Reactors. The objective was to elucidate factors which influ-The objective was to elucidate factors which influence formation and maintenance of highly active self-agglomerated microbial biomass. Simultaneous examination of biological and physical parameters was performed during the start-up of a calcium-positive (100 mg/L) reactor and a reactor without added calcium. The influence of carbon nutrients and Ca(2+) on the cell surface and microbial aggregation was studied. The granules formed in both reactors but were larger in the calcium-posiboth reactors but were larger in the calcium-positive reactor in which they settled 3-4 times faster. A higher rate of biomass accumulation also was evident in the calcium-positive reactor and this allowed a more frequent increase in the substrate loading rate and earlier development of the granular sludge. (Author's abstract)
W87-10067

INFLUENCE OF THE CARBON SOURCE ON MICROBIOLOGICAL CLOGGING IN AN AN-AEROBIC FILTER,

Lyonnaise des Eaux, Le Pecq (France). Lab. Cen-R. Ehlinger, J. M. Audic, D. Verrier, and G. M.

Descriptors: \*Anaerobic filters, \*Bacteria, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Substrates, Clogging.

Using two different substrates, glucose and a mix-ture of volatile fatty acids, the influence of the types of bacteria on the appearance of microbiolo-gical clogging in anaerobic filters was studied. The clogging was detected by lithium tracings and head-loss profiles. The composition of the biofilm and the electron-microscopy were used to illustrate the phenomenon. The clogging is due to polysac-charides secreted by acidogenic bacteria. (Author's abstract) abstract) W87-10068

STEADY STATE KINETICS OF ANAEROBIC DOWNFLOW STATIONARY FIXED FILM RE-ACTORS.

Ottawa Univ. (Ontario). Dept. of Civil Engineer-

ing.
R. L. Droste, and K. J. Kennedy.
Water Science and Technology WSTED4, Vol.
19, No. 1/2, p 275-285, 1987. 6 fig. 2 tab, 17 ref.

Descriptors: \*Anaerobic digestion, \*Model studies, \*Washout, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Substrates, Re-

Anaerobic downflow stationary fixed film reactors operated at 35 C successfully treated synthetic (sucrose based) wastewater of different concentra-(sucrose based) wastewater of different concentrations at high organic loading rates and short hydraulic retention times. Based on observed relations between washout solids retention time, hydraulic retention time and loading rate, an empirical model of the process was formulated. Incorporation of the washout factor into accepted theory allowed good prediction of chemical oxygen demand removal efficiency and reactor biomass concentration. (Author's abstract)

ANAEROBIC FLUIDIZED BED TREATMENT WITH A STEADY-STATE BIOFILM, Kurita Water Industries Ltd., Yokohama (Japan). M. Yoda, S. W. Shin, A. Watanabe, M. Watanabe, and M. Kitagawa.

Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 287-298, 1987. 7 fig, 6 tab, 8 ref.

Descriptors: \*Anaerobic digestion, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Biofilm, Biomass.

The operational conditions for establishing a dy-namic balance between the microbial growth and loss in the anaerobic fluidized bed process is studloss in the anaerobic fluidized bed process is studied. Such operation is very attractive because there is no necessity of complicated bed and biofilm control or costly excess sludge treatment and disposal. Several factors which control the dynamic balance were identified and experimentally determined using laboratory scale anaerobic fluidized beds. Based upon the knowledge accumulated through the laboratory experiments, a pilot scale anaerobic fluidized bed (1.0 m ID x 6.85 m H) was installed at a soft-drink bottling plant and successfully operated for nine months. The stable microbial mass along with low effluent organic concentration demonstrated the feasibility of the anaerobic fluidized bed treatment with a steady-state biofilm. (Author's abstract) (Author's abstract)

TEMPERATURE CHARACTERISTICS OF THE METHANOGENESIS PROCESS IN ANAERO-BIC DIGESTION,

BIC DIGESTION, Feng Chia Univ., Taichung (Taiwan). Dept. of Hydraulic Engineering. C. Y. Lin, T. Noike, K. Sato, and J. Matsumoto. Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 299-310, 1987. 13 fig, 2 tab, 8 ref.

Descriptors: \*Anaerobic digestion, \*Temperature effects, \*Wastewater treatment, \*Industrial wastewater, Wastewater, Effluents, Methane bac-

Experiments using high concentration of the major intermediates of anaerobic digestion were conducted with anaerobic chemostat-type reactors to ined with anaerobic chemostaf-type reactors to investigate the temperature characteristics of the methanogenesis process. Temperature ranging from 15 C to 50 C were studied. The optimum temperature was 35 C. The methane production was temperature and loading rate dependent. Bacilli were the predominant microbial species and this predominance was independent of digestion temperature. At the mesophilic range, with increasing temperature the saturation constant (Ks) decreased, while the maximum specific substrate utilization rate (nu sub max) and growth yield (Yg) increased. Their temperature characteristics were described using exponential expressions. For retendescribed using exponential expressions. For reten-tion times longer than 8 days, the process pro-gressed normally and satisfactorily even at 25 C, and the substrate removal efficiency was more than 96% which was the same as that at 35 C.

EVALUATION OF EFFECTIVENESS OF TWO-PHASE ANAEROBIC DIGESTION PROCESS DEGRADING COMPLEX SUBSTRATE,

Tokyo Univ. (Japan). Dept. of Urban Engineering. K. Hanaki, T. Matsuo, M. Nagase, and Y. Tabata. Water Science and Technology WSTED4, Vol. 19, No. 1/2, p 311-322, 1987. 13 fig, 2 tab, 8 ref.

Descriptors: \*Anaerobic digestion, treatment, wastewater, Wastewater, Effluents, Reactors,

The effectiveness of two-phase anaerobic digestion in degrading complex substrates was studied by using a continuous acidogenic reactor and batch using a continuous acidogenic reactor and batch experiments. When 4,600 mg COD/L of milk consisting of carbohydrates, proteins and lipids, was fee to the acidogenic reactor, carbohydrates were easily converted to acids although protein degradation was insufficient and lipids were not degraded. The condition which gave greater than 95% carbohydrate degradation was a pH of not less than 4.5 at a constant HRT of 18 hours, and HRT league than 6 hours etc. longer than 6 hours at a constant pH of 6.0. Low pH or short HRT within the optimal range brought about the production of more n-butyrate

instead of propionate. Degradation of egg albumin in the two-phase system required a longer HRT (about 5 days) than the ordinary acidogenic reactor. Batch experiments using the mixed liquor from the acidogenic reactor suggest that phase separation is not very effective for the degradation of carbohydrates and proteins, but it can prevent the inhibition caused by lipids. (Author's abstract) W87-10072

COMPARATIVE STUDY OF THE AIR AND OXYGEN ACTIVATED SLUDGE SYSTEMS,

National Technical Univ., Athens (Greece), Dept. of Civil Engineering.
A. D. Andreadakis.

Environmental Technology Letters ETLEDB, Vol. 8, No. 5, p 209-220, May 1987. 10 fig, 1 tab, 22

Descriptors: \*Comparison studies, \*Wastewater treatment, \*Activated sludge, Air, Oxygen, Energy, Performance evaluation, Sludge.

A comparative study of air and pure oxygen activated sludge systems, with respect to energy requirements and performance characteristics was showed that despite the higher efficiency of absorption the oxygen system is in most practical cases more energy demanding that the six extens sorption the oxygen system is in most practical cases more energy demanding than the air system. Treatment efficiencies and sludge production rates were found to be similar in both cases. However, the oxygen system produced a sludge with better settling characteristics, particularly when operated at low BOD loadings. (Author's abstract)

TECHNIQUE FOR THE ENUMERATION OF PROTOZOA IN WASTEWATER, M. Norouzian, A. Herroz-Zamorano, and C.

Environmental Technology Letters ETLEDB, Vol. 8, No. 5, p 221-224, May 1987. 1 fig, 1 tab, 5

Descriptors: \*Analytical methods, \*Wastewater treatment, \*Protozoa, Sample preparation, Sludge.

A method designed to enumerate protozoa in wastewater sludge or mixed liquor is described in which a microscope slide, divided into parallel sections by nylon strings is used. The sample is treated with xylocaine and placed on the specially designed slide prior to microscopic observation of the sample. The method was applied to sludge samples from a rotating biological contactor, indi-cating that the method can be used to produce statistically uniform results. (Author's abstract)
W87-10087

FLY ASH FOR THE TREATMENT OF CD(II) RICH EFFLUENTS,
Banaras Hindu Univ., Varanasi (India). Inst. of

1ech.
K. P. Yadava, B. S. Tyagi, K. K. Panday, and V.
N. Singh.
Environmental Technology Letters ETLEDB,
Vol. 8, No. 5, p 225-234, May 1987. 9 fig. 2 tab, 26

Descriptors: \*Adsorption, \*Fly ash, \*Cadmium, \*Effluents, \*Wastewater treatment, \*Adsorption, Kinetics, Temperature, Heavy metals, Complexes.

The removal of Cd(II) by adsorption on fly ash has been found to be contact time, concentration, temperature and pH dependent. The process of removal follows first order adsorption kinetics and the rate controlling step is intraparticle transport into the pores of fly ash particles. The equilibrium nature of Cd(II) adsorption at different temperatures has been described by the Langmuir isotherm. The temperature dependence of Cd(II) adsorption on fly ash indicates the exothermic nature of adsorption. Alkaline aqueous medium favors the removal of Cd(II) with pH has been explained on the basis of surface complex formation approach. (Author's abstract) The removal of Cd(II) by adsorption on fly ash has

#### Ultimate Disposal Of Wastes-Group 5E

INFLUENCE OF DIGESTION ON SEWAGE SLUDGE STABILITY AND DEWATERABILITY: PRELIMINARY RESULTS, Yanshan Petrochemical Corp., Beijing (China).

. Van. Environmental Technology Letters ETLEDB, Vol. 8, No. 5, p 249-259, May 1987. 7 fig, 2 tab, 15

Descriptors: \*Wastewater treatment, \*Sludge sta-bility, \*Sludge dewatering, \*Sludge digestion, Per-

Research was carried out at CNR-Istituto di Ri-cerca Sulle Acque (CNR-IRSA) to investigate the influence of aerobic and anaerobic digestion time on sewage sludge stability and dewaterability. A stable sludge, measured by volatile suspended solids concentration, was obtained after about 15 days of aerobic digestion and 25:30 of anaerobic solids concentration, was obtained after about 15 days of aerobic digestion and 25-30 of anaerobic digestion. Results showed that, owing to its scarce effect compared to that of chemical and thermal conditioning, the influence of digestion time on dewaterability, as measured by specific resistance to filtration and compressibility, can be neglected. (Author's abstract) W87-10089

RECURSIVE WATER QUALITY FORECAST-ING MODELS FOR URBAN CATCHMENTS, For primary bibliographic entry see Field 7C. W87-10108

USE OF PEAT IN WATER POLLUTION CON-TROL: A REVIEW,

For primary bibliographic entry see Field 5G. W87-10109

OZONE DISINFECTION OF SECONDARY EF-FLUENT CONTAINING ANTIBIOTIC-RESIST-ANT ESCHERICHIA COLI,

ANT ESCHERICHIA COLL, G.R. Finch, and D. W. Smith. Canadian Journal of Civil Engineering CJCEB8, Vol. 14, No. 2, p 234-238, April 1987. I fig. 5 tab, 41 ref. Alberta Environmental Research Trust Grant T0937 and NSERC Grant A1010.

Descriptors: \*Wastewater treatment, \*Ozonation, \*Disinfection, \*Escherichia, \*Effluents, \*Activated sludge, Ozone, Bacteria, Antibiotic resistance.

A paired experiment using seven batches of activated sludge final effluent was used to determine the effect of ozone on the multiple-antibiotic-resistant (MAR) population of Escherichia coli. The experiments were conducted using a batch stirred tank reactor. No statistically significant difference was found in the proportions of MAR E. coli in the ozonated secondary effluent when compared with the nonozonated effluent. This was true for all levels of multiple resistance including simultaneous resistance to greater than or equal to five antibiotics. This suggests that using ozone for all levels of multiple resistance including simultaneous resistance to greater than or equal to five antibiotics. This suggests that using ozone for water and wastewater disinfection will not select for antibiotic-resistant bacteria as has been reported by other investigators for chlorine and ultraviolet radiation. (Author's abstract) W87-10110

BIOLOGICAL PHOSPHORUS REMOVAL AT AN EXPERIMENTAL FULL-SCALE PLANT IN

M. Florentz, M. C. Hascoet, and F. Bourdon. Canadian Journal of Civil Engineering CJCEB8, Vol. 14, No. 2, p 278-283, April 1987. 4 fig, 5 tab,

Descriptors: \*Biological wastewater treatment, \*Wastewater treatment, \*Phosphorus removal, \*Chemical precipitation, France, Costs, Aeration.

In France, all phosphorus removal treatment has been based on precipitation by means of chemical reagents. With a view to reducing costs, a series of laboratory experiments was initiated and subsequently followed up by full-scale studies in early 1984 at the Saint-Mars-la-Jaille treatment plant. This is the first biological P-removal plant to be put on line in France. The plant operates at low

loading levels with extended aeration. Nitrification - denitrification is achieved in controlled aerobic and nonaerobic zones through a multi-mini-step process in a plug - flow reactor. Complete nitrate removal results in a release of phosphorus during the anaerobic phase and, hence in a high level of phosphorus accumulation in the aerobic sludge. Phosphorus removal was optimized by replacing the thickener with a new floation thickener to minimize P-release in the anaerobic sludge blanket. The phosphorus removal levels obtained varied from 35% at the outset of the study to 89% upon stabilization. This paper outlines the basic technical alterations made to ensure efficient phosphorus removal with this type of sewage plant as well as the analytical procedures used, and identifies the polyphosphates accumulated in activated sludge; on the basis of 31-phosphorus nuclear magnetic resonance (31P mmr). Results concerning phosphorus removal at low temperatures are also provided. (Author's abstract) (Author's abstract) W87-10111

#### 5E. Ultimate Disposal Of Wastes

WASTE DISPOSAL IN THE SEA OFF SOUTH-ERN CALIFORNIA,

California Univ., San Diego, La Jolla, Inst. of Marine Resources.

W. Bascom.
Water Science and Technology WSTED4, Vol. 18, No. 11, p 1-9, 1986. 4 fig, 1 tab, 10 ref.

Descriptors: \*Wastewater disposal, \*Outfall, \*Waste disposal, \*Wastewater, Coastal waters, Effluents, Wastewater dilution, Diffusers, California.

Southern California, with a coastal population of 12 million people, releases about 4.4 million cubic meters of treated waste water into the Pacific every day via outfalls that discharge three to six kilometers offshore at a depth of 60 meters. Diffusers cause each liter of waste to be diluted by 150 liters of deep cool water preventing it from reaching the surface except for short periods in winter. Data on the constituents of the four largest waste streams are presented and a brief account of the research done by the Southern California Coastal Water Research Project is given. Although the waste water now discharged meets rigorous state standards (with minor exceptions) and the steady improvement in sea conditions over a decade has been well documented, there is a continuing debate improvement in sea conditions over a decade has been well documented, there is a continuing debate over whether our coastal waters are adequately protected. This is primarily because the damaging effects of DDT and PCBs that were discharged more than 14 years ago have been slow to go away. Although the amounts of DDT and PCB in sea animals are only one-tenth what they were a decade ago they tend to obscure the value of the improvements and the present discharge practices. The alternatives to sea disposal seem likely to cause greater damage to the overall environment. (Author's abstract)

W87-09633

MARINE OUTFALL STUDIES IN DEVELOP-MENT AREAS OF SOUTH AFRICA, National Research Inst. for Oceanology, Stellen-bosch (South Africa). Hydrodynamics and Water Quality Div.

Water Science and Technology WSTED4, Vol. 18, No. 11, p 11-23, 1986. 8 fig, 1 tab, 22 ref.

Descriptors: \*Wastewater disposal, \*Outfall, \*Waste disposal, \*Wastewater, Coastal waters, Effluents, Ocean dumping, South Africa, Planning, During, State of the Computer of

A recent policy of decentralizing growth in South Africa has led to the designation of new coastal development areas. Growth of such areas, stimulat-ed by the attraction of industries should be accom-panied by a careful assessment of possible associat-ed marine pollution problems. In particular, the disposal of industrial and/or domestic effluents to see may nitially anger an attractive option to sea may initially appear an attractive option to planners and developers. Consequently the investi-gation of the feasibility of the marine disposal

option is an essential component of the planning process. An on-going series of such studies in nominated priority coastal development areas has been undertaken by the National Research Institute for Oceanology since 1980. This paper reviews the progress of these studies and outlines the preliminary engineering and oceanographic investigations. Two case studies, Saldanha and Richards Bay, are reviewed. The Richards Bay effluent is a combination of buoyant pulp-mill waste and not Bay, are reviewed. The Kichards Bay effluent is a combination of buoyant pulp-mill waste and non-buoyant dense hypsum waste. The final design recommendation called for a dense effluent outfall diffuser at 23 meters water depth containing 16 ports at 10 meter centers. For the buoyant effluent a traditionally long diffuser containing 106 ports of minimum internal diameters of 75 mm was recommitment. minimum internal diameters of 75 mm was recom-mended in 29 meters water depth. Both lines have been completed to 3.8 km for the dense effluent and 5.5 km for the buoyant effluent; both lines are high density polyethylene pipelines. (Alexander-

MAINTAINING SCIENTIFIC INTEGRITY UNDER PRESSURE: THE EXPERIENCE OF THE SOUTHERN CALIFORNIA WATER RE-SEARCH AUTHORITY,

SEARCH AUTHORISTS.

J. B. Garber.

Water Science and Technology WSTED4, Vol. 18, No. 11, p 25-34, 1986. 1 fig, 8 ref.

Descriptors: \*Wastewater disposal, \*Outfall, \*Waste disposal, \*Wastewater, Coastal waters, Effluents, California, Legislation, Recreation.

The experience of the City of Los Angeles demonstrates that if political pressures are combined with ignorance of both economics and science on the ignorance of both economics and science on the part of active participants in a democracy, a city can be forced into unnecessary and expensive anti-pollution measures. The author has been for 14 years, since 1972, the representative of the City of Los Angeles on the governing board for the Southern California Coastal Water Research Southern California Coastal Water Research Project (SCCWRP) formed in 1969 by five south-ren California sewage discharging agencies, to obtain a data base on the ecology of the near-shore ocean waters and the effects of sewage on those waters, in order to ensure that legislation and regulations concerning that discharge would be rationally based. The project SCCWRP, is a small research laboratory with capabilities in physics, chemistry, biology and engineering. Because the only source of available funding was the agencies themselves, two mechanisms were put into place. cnemstry, biology and engineering. Because the only source of available funding was the agencies themselves, two mechanisms were put into place, in order to ensure the scientific credibility of the research: (1) a commission of five elected representatives, one from each of the sponsoring agencies, would be responsible to the public, and (2) a consulting board of eminent scientists, with no political connection to any of the agencies, would guide the research and lend the weights of their reputations to the results. The commission selects both the consulting board and the project manager. In actuality, the commission is not seen as a presence which bestows reliability on the research; for the scientific community, the integrity of the research done has depended, as it always does, on publication of reports and review of the procedures by fellow scientists. The commission, although powerful, is invisible. For the public, the research results are made to speak for themselves, and they are interpreted in the light of the demand for 100% purity of both seafood and bathing waters. (Author's abstract)

EFFECTS OF SEWAGE OUTFALLS ON INTER-TIDAL ECOSYSTEMS IN KUWAIT. Kuwait Inst. for Scientific Research, Safat. Dept. of Environmental Sciences.

For primary bibliographic entry see Field 5C. W87-09636

HISTORY AND APPLICATION OF MICRO-BIOLOGICAL WATER QUALITY STANDARDS IN THE MARINE ENVIRONMENT, Pan American Center for Sanitary Engineering and Environmental Sciences, Lima (Peru). For primary bibliographic entry see Field 5G.

#### Group 5E-Ultimate Disposal Of Wastes

W87-09637

ASSOCIATION BETWEEN MORBIDITY AMONG BATHERS AND MICROBIAL QUAL-ITY OF SEAWATER,

Hadassah Medical School, Jerusalem (Israel). Environmental Health Lab.

For primary bibliographic entry see Field 5C. W87-09638

MILLISCREENING: A PRETREATMENT OPTION FOR MARINE DISPOSAL, Hutt Valley Drainage Board, Lower Hutt (New

For primary bibliographic entry see Field 5D. W87-09639

EVALUATION OF THE EFFICIENCY OF SANTOS/SAO VICENTE PRECONDITIONING STATION FOR AN OCEANIC SUBMARINE OUTFALL,

Companhia de Tecnologia de Saneamento Am-biental, Sao Paulo (Brazil).

For primary bibliographic entry see Field 5D. W87-09640

EFFECT OF SEWAGE SLUDGE DISPOSAL TO SEA THROUGH PIPELINES PREVIOUSLY DISCHARGING ONLY SETTLED EFFLUENT. Water Research Commission, Pretoria (South

For primary bibliographic entry see Field 5C. W87-09641

PRE-DESIGN OCEAN OUTFALL STUDIES.

Scripps Institution of Oceanography, La Jolla, CA. W. Bascom.

Water Science and Technology WSTED4, Vol. 18, No. 11, p 105-110, 1986. 5 ref.

Descriptors: \*Planning, \*Wastewater disposal, \*Outfall, \*Waste disposal, \*Wastewater, Coastal waters, Effluents, Research, Costs.

This paper is intended to provide guidance to persons in developing countries who are responsible for making ocean outfall studies but have limited resources. It consists mainly of practical suggestions based on the author's experience about what measurements are needed to obtain useful information and how to make them at minimal cost. tion and how to make them at minimal cost. Thoughtfulness in planning work that will produce useful answers is favored over pseudo-high-tech environmental studies. Some opinions are presented about the enhancement of marine food resources by outfalls and about collecting biological data as a defense against possible criticism. The special conditions that may exist in enclosed bays and estuaries are not specifically addressed in this paper. (Author's abstract) paper. (Author's abstract) W87-09642

USE OF CURRENT DATA IN OCEAN OUT-FALL DESIGN, Georgia Inst. of Tech., Atlanta. School of Civil

P. J. W. Roberts.

Water Science and Technology WSTED4, Vol. 18, No. 11, p 111-120, 1986. 10 fig. 11 ref.

Descriptors: \*Water currents, \*Design criteria, \*Wastewater disposal, \*Outfall, \*Waste disposal, \*Wastewater, Coastal waters, Effluents, Puget Sound, Transport, California

Some of the ways in which current meter data can aid in the design of ocean outfalls are discussed. Examples are given, which include time series analyses of currents obtained in Puget Sound, near Alki Point, the prediction of initial dilution of San Francisco, the prediction of far field dilution and transport in Southern California coastal waters, and prediction of the visitation frequency, or transport probability, off Alki Point. (Author's abstract) W87-09643

DILUTION PREDICTION FOR OCEAN OUTFALLS,

Georgia Inst. of Tech., Atlanta. School of Civil P. I. W. Roberts.

Water Science and Technology WSTED4, Vol. 18, No. 11, p 121-130, 1986. 8 fig, 17 ref.

Descriptors: \*Wastewater dilution, \*Mathematical equations, \*Wastewater disposal, \*Outfall, \*Waste disposal, \*Wastewater, Coastal waters, Effluents, Estimating, Jets, Prediction

Methods for predicting initial dilution and rise height of wastefields produced by ocean outfalls neight of wasterleds produced by ocean outrails are reviewed. Equations are presented for estimating these parameters for limiting cases dependent on whether the jets are merging or non-merging, and on whether the receiving water is stagnant or flowing, density stratified or uniformly mixed. (Author's abstract) W87-09644

EXPERIMENTAL MEASUREMENT OF TURBULENT DIFFUSION, INITIAL DILUTION AND T SUB 90,

Companhia de Tecnologia de Saneamento Ambiental, Sao Paulo (Brazil).

E. G. Agudo, and J. L. dos Santos.

Water Science and Technology WSTED4, Vol. 18, No. 11, p 131-140, 1986. 3 fig, 8 tab, 11 ref.

Descriptors: \*Turbulent diffusion, \*Wastewater di-lution, \*Wastewater disposal, \*Outfall, \*Waste dis-posal, \*Wastewater, Coastal waters, Effluents, Design criteria, Bacteria, Brazil, Tracers.

The final disposal of sewage using submarine out-falls has become an actual solution for coastal cities all over the world. In order to get the best results it is necessary to carry out specific studies for the proper design of the outfall. Dilution and decrease in bacterial concentrations are two key aspects for the design. Radioisotope tracers have been used the design. Radioisotope tracers have been used extensively in studies performed in some Brazilian waterbodies where outfall systems exist or are to be installed. As far as dilution measurement is concerned, both point and continuous radiotracer injections can provide useful results. The T sub 90 sampling the sewage field, using the radiotracer for dilution measurement and rhodamine B as a visual aid. Typical results of dilution measurement using both tachinges mentioned as well as a summary both techniques mentioned, as well as a summary of T sub 90 results obtained for the Santos, Fortaleza and Maceio outfalls are presented. (Author's W87-09645

CONCEPTUAL APPROACH TO OCEAN DIS-

Hidrosistem Engenheiros Consultores Ltd., Sao Paulo (Brazil). A. G. Occhipinti.

Water Science and Technology WSTED4, Vol. 18, No. 11, p 141-158, 1986. 5 fig. 1 tab, 14 ref.

Descriptors: \*Model studies, \*Design criteria, \*Wastewater disposal, \*Outfall, \*Waste disposal, \*Wastewater, Coastal waters, Effluents, Research, Statistics, Field tests, Simulation.

An ocean waste disposal system (OWDS) is a complex multidisciplinary engineering problem. The aim of this paper is to focus on the most relevant aspects, pointing out the most important processes and parameters and analysing how they interact. A research program for field data collection and statistical analysis is recommended to define presenters. define parameters. The modelling of specific processes must contribute to a simulation which relates esses must contribute to a simulation winch relates and weights the major factors and parameters op-erating. A conceptual simulation model is shown to be useful in designing the general layout of the system, and to predict its performance and envi-ronmental impact. Finally an optional optimization model is suggested for use with the simulation to define further the optimum OWDS design. (Au-W87-09646

KEY ISSUES IN PLANNING SUBMARINE OUTFALLS FOR SYDNEY, AUSTRALIA, Sydney Water Board (Australia). Major Projects Branch.

Branca. K. G. Clancy, and D. J. Carroll. Water Science and Technology WSTED4, Vol. 18, No. 11, p 159-170, 1986. 9 fig, 4 tab, 9 ref.

Descriptors: \*Design criteria, \*Wastewater disposal, \*Outfall, \*Waste disposal, \*Wastewater, Coastal waters, Effluents, Australia, Costs, Construction.

This paper describes three large tunnelled submarine ocean outfalls, planned to safely discharge primary effluent from about two-thirds of the regional population of Sydney, Australia into deep ocean water. Environmental and investigation aspects are dealt with briefly. Interesting aspects of design and construction planning are described. The design includes the handling of special hydraulic problems such as dilution and salt water removal. The construction planning foreshadows the extensive use of tunnelling machines including roadheaders and a full face tunnel boring machine. The offshore engineering describes the design and testing of innovative G R P risers and diffusers, and their intended installation by a semi-submersible drill ship using standard oil field techniques. The cost estimate and program is included. (Author's abstract)

UTILIZATION OF PLASTIC PIPE FOR SUB-MARINE OUTFALLS - STATE OF THE ART, VBB/SWECO Consulting Group, Stockholm

Water Science and Technology WSTED4, Vol. 18, No. 11, p 171-176, 1986. 12 ref.

Descriptors: \*Plastic pipe, \*Wastewater disposal, \*Outfall, \*Waste disposal, \*Wastewater, Coastal waters, Effluents, Sweden, Technology, Design

During the last 25 years, a great number of subma-rine pipelines have been built in Scandinavia. They are all a result of intensive activity in the field of environmental control, the consequence of which has often been that the last purification step in the has often been that the last purification step in the wastewater treatment process has been considered to be the dilution of the residual waste into the ocean. Efforts have been made to develop a new piping technology which would allow great depths and points situated far off-shore to be reached, and points situated far off-shore to be reached, where the risk of problems due to floatable materials flowing back to the shore is insignificant. It has been regarded as especially essential to find a technique which would enable a cheap and rapid procedure for pipe submersion even far off-shore and in heavy sea conditions. The reason for this is that a major proportion of the cost of a submarine pipeline relates to submersion work. Additional requirements were that the pipe material should withstand sudden and even exceptional wave forces and also permit uneven settlements as well forces and also permit uneven settlements as well as movement of sediment on the sea bed. Thus, the aim has been to develop a highly flexible pipe. The paper presents the state of the art by referring to a submarine outfall project implemented in Sweden submarine outfall project implemented in Sweden 1985. Some need for further development is also discussed. (Author's abstract)

TEN YEARS OF OPERATION OF RIO DE JANEIRO'S IPANEMA SUBMARINE OUTFALL, Companhia Estadual de Agua e Esgotos do Rio de eiro (Brazil).

E. R. Britto, E. P. Jordao, J. Semeraro, and W. M.

Water Science and Technology WSTED4, Vol. 18, No. 11, p 177-187, 1986. 8 fig, 2 tab, 6 ref.

Descriptors: \*Maintenance, \*Wastewater disposal, \*Outfall, \*Waste disposal, \*Wastewater, Coastal waters, Effluents, Monitoring, Surveys, Brazil, Water quality.

Monitoring and surveys of the Ipanema Submarine Outfall of the city of Rio de Janeiro have been practiced during the 10 years of the outfall oper-

#### Water Treatment and Quality Alteration-Group 5F

ation. The outfall is a 2.4m diameter prestressed concrete pipeline, 4.3 km long, extending 3.3 km seaward to a depth of 27m. It discharges presently 6 cu m/s average raw sewage flow, through 450m long diffuser. A planned survey program was established in order to verify pipe conditions through periodical deep sea inspection, monitored by radio and video recording; this paper discusses the preventive and corrective maintenance of the through periodical deep sea inspection, monitored by radio and video recording; this paper discusses the preventive and corrective maintenance of the outfall, especially the failures that occurred in 5 accidents. It discusses also the water quality monitoring program established one year before the outfall began its operation in 1975. A program had been prepared which established beneficial water uses, water quality standards required for protection of the uses, and a monitoring system which provides the input data for verifying compliance with the standards. Pre-discharge studies were conducted for one year prior to operation, to provide background data on the various parameters, and over 70,000 analyses were made during the 10 years of the outfall operation. This paper evaluates the results of grease, coliforms, and hydrobiological indicators, as the most representative parameters of water quality in the sea. It shows that a marked improvement has occurred in the water quality. It also shows that the beaches receive a great amount of pollution through the canals of Visconde de Albuquerque Avenue and Jardim de Ala (Rodrigo de Freitas Lagoon), due to sewage overflows from the sewer network and the stormwater networks. The importance of giving special attention to the sewer network in systems involving submarine outfalls is stressed. (Author's abstract) stract) W87-09649

DYE STUDIES OF INITIAL DILUTION AND THE APPLICABILITY OF THE STAGNANT WATER DESIGN, National Research Inst. for Oceanology, Stellenbosch (South Africa). Hydrodynamics and Water Outlity Dir.

bosch (South Anne).

Quality Div.

G. Toms, and W. A. M. Botes.

Water Science and Technology WSTED4, Vol.

18, No. 11, p 189-197, 1986. 4 fig, 1 tab, 8 ref.

Descriptors: \*Wastewater dilution, \*Design criteria, \*Tracers, \*Stagnant water, \*Wastewater disposal, \*Outfall, \*Waste disposal, \*Wastewater, Coastal waters, Effluents, Hydrodynamics.

In the preliminary design of an ocean outfall to discharge buoyant effluent a standard estimate of the initial dilution achieved at the water surface the initial dilution achieved at the water surface above the diffuser is useful to compare options for diffuser depth and diffuser design. The standard estimate or prediction of initial dilution that is often used is that pertaining to a worst case for surface contamination occurring during stagnant (zero current)-uniform (zero stratification) sea conditions. This paper describes a series of measurements of the initial dilution achieved by an operating outfall and by a pilot full-scale experimental ing outfall and by a pilot full-scale experimental set-up. The measurements, conducted near Cape Town, South Africa, using Rhodamine-B dye as tracer were performed on days when sea conditions very close to stagnant-uniform pertained. A consistent trend for the lowest measured dilution to exceed the predicted stagnant-uniform dilution by a factor of 2 to 3 times was evident from four separate field experiments. The applicability of the stagnant-uniform design approach to a prototype, operating outfall is consequently discussed in the paper. (Author's abstract)

SOME BASIC CONSIDERATIONS FOR MARINE DISPOSAL OF WASTEWATER AND

MARINE DISPUSAL OF WASTEWATER AND SOLID WASTES, Setsunan Univ., Neyagawa (Japan).
T. Goda, and M. Watanabe.
Water Science and Technology WSTED4, Vol. 18, No. 11, p 199-204, 1986. I fig, 6 tab, 13 ref.

Descriptors: \*Water pollution effects, \*Ocean dumping, \*Wastewater disposal, \*Outfall, \*Waste disposal, \*Wastewater, Coastal waters, Effluents, Japan, Trace elements, Settling.

Renewal time and circulation rate are calculated for lakes, rivers and oceans. The annual circulation

of the oceans is found to be only four times that of of the oceans is found to be only four times that of lakes in absolute amount. The dump sites, categories of wastes and tonnages for the disposal of wastes in the sea in Japan are discussed in detail. The dumping of sewage sludge in Japan is severely restricted due to the effects of trace elements on the marine ecosystem. Results of laboratory tests on the settling characteristics of sewage sludge, toxic effects of ammonia on fish and biomagnification are summarized. (Author's abstract)

ENVIRONMENTAL LAWS AND ENVIRON-MENTAL IMPROVEMENT,

Quad Consultants, Visalia, CA. For primary bibliographic entry see Field 6E. W87-09652

OCEAN DISPOSAL SYSTEMS FOR SEWAGE SLUDGE AND EFFLUENT.

Quad Consultants, Visalia, CA. W. F. Garber.

Water Science and Technology WSTED4, Vol. 18, No. 11, p 219-226, 1986. 3 fig, 3 tab, 8 ref.

Descriptors: \*Ocean dumping, \*Wastewater disposal, \*Outfall, \*Waste disposal, \*Wastewater, Coastal waters, Effluents, Research, Design crite-

In 1983 the Marine Board, Commission on Engineering and Technical Systems, National Research Council-Academy of Sciences organized a Committee on Ocean Waste Transportation to consider the question of Ocean Disposal Systems for Sewage Sludge and Effluent'. A report of the work of the Committee was published by the National Academy Press in 1984. A comprehensive contract study of outfall and barge or ship disposal procedures for sludge solids was study of outfall and barge or ship disposal procedures for sludge solids was made for Committee use. This helped show that a systems approach is required to found that a systems approach is required to found that a systems approach is required to found that a systems approach is required to the optimum combination of source control, treatment and ocean disposal facilities for least net environmental effect. The Committee also noted that engineering designs can be based upon required water quality objectives for the water column and benthos; and ocean disposal is an option that should be considered with other alternatives. The Committee found it possible to predict the environmental effects of such marine disposal and criteria were proposed for sludge disposal. A strategy of wide dispersion was recommended since containment was not considered technically feasible. The Committee recommended that monitoring systems be designed and operated so that public confidence in the reliability and environmental safety of ocean disposal of treated sewage effluent and sludge was enhanced. Major research needs were identified. (Author's abstract) In 1983 the Marine Board, Commission on Engi-W87-09653

MODELING OF GROUND-WATER FLOW IN THE CULEBRA DOLOMITE AT THE WASTE ISOLATION PILOT PLANT (WIPP) SITE: IN-

INTERA Technologies, Inc., Austin, TX. For primary bibliographic entry see Field 2F. W87-09684

AVAILABILITY AND DISTRIBUTION OF HEAVY METALS, NITROGEN, AND PHOSPHORUS FROM SEWAGE SLUDGE IN THE PLANT-SOIL-WATER CONTINUUM,

Virginia Polytechnic Inst. and State Univ., Blacks-burg. Dept. of Agronomy. For primary bibliographic entry see Field 5B. W87-09753

CONTROL AND DRAINAGE OF WATER IN MINE TAILINGS DAMS, Carleton Univ., Ottawa (Ontario). Dept. of Civil

Engineering. For primary bibliographic entry see Field 5G. W87-09894

OXYGEN DIFFUSION AND MICROBIAL AC-TIVITY IN THE COMPOSTING OF DEHY-DRATED SEWAGE CAKES, Shizuoka Univ., Hamamatsu (Japan). Dept. of

Chemical Engineering. K. Nakasaki, Y. Nakano, T. Akiyama, M. Shoda,

A Makssan, 1 - Manager and H. Kubota. Journal of Fermentation Technology JFTED8, Vol. 65, No. 1, p 43-48, February 1987. 7 fig. 5 ref.

Descriptors: \*Sludge cake, \*Wastewater treatment, \*Sludge digestion, \*Oxygen diffusion, \*Microbial degradation, Oxygen, Diffusivity, Composting, Porosity, Mathematical equations, Mathematical stud-

The effective diffusivity for oxygen within sewage sludge cakes was measured, and in turn used for the study of microbial activity in the sludge cake composting. The diffusivity was proportional to the one and a half power of the sludge cake porosity. Composting experiments were done using two types of sludge cakes, 5 mesh sieved and pelletized. It was found that the microbial activity in the inner core region of the pelletized sludge cake was significantly less than that in the outer region, even though the rate of oxygen diffusion case was significantly less than that in the outer region, even though the rate of oxygen diffusion was fast enough to support the microorganisms' activities. It appears, therefore, that microorga-nisms acting to degrade organic matter grow pri-marily on the macroscopic interface between solids and air. (Author's abstract) W87-09923

FATE OF ORGANIC COMPOUNDS IN LAND APPLICATION OF CONTAMINATED MUNIC-IPAL SLUDGE,

Muskegon County Wastewater Management System, M. Y. A. Demirjian, A. M. Joshi, and T. R. Westman. Journal of the Water Pollution Control Federation JWPFA5, Vol. 59, No. 1, p 32-38, January 1987. 4 fig, 6 tab, 13 ref.

Descriptors: \*Fate of pollutants, \*Sludge disposal, \*Land disposal, \*Soil amendments, \*Organic compounds, \*Municipal wastewater, Cost analysis, Crop production, Wastewater, Recycling, Accumulation, Bioaccumulation, Acids, Organic acids, Hudscost-base cumulation, Acids, Organic acids,

A study was undertaken at the Muskegon County (MI) Wastewater Management Treatment System to demonstrate the fate of organic compounds in studge applied to soil and to extrapolate the consequences of repeated applications of contaminated sludges. Because of the industrial nature of the sludges. Because of the industrial nature of the effluent, sludge accumulated in the aeration cells contains a variety of compounds, many of which are known or suspected carcinogens. It was concluded that the sludge does not seem to have any adverse effect on the environment if applied in moderation. Below the 224,072 kg/ha application rate, most compounds were found to degrade considerably during one irrigation season. At less than 56,018 kg/ha, most compounds degraded to less siderably during one irrigation season. At less than 56,018 kg/ha, most compounds degraded to less than 50% of initial concentrations. This rate seems safe for repetitive, annual applications with continued monitoring as long as metal and nutrient concentrations are acceptable. The sandy soil of Muskegon County and heavy irrigation requirements represent severe conditions for sludge treatment; other municipalities can probably treat their sludge more effectively. Affinity of hard-to-treat industrial compounds to sludge may be an efficient way to concentrate contaminants from groundwater. Recycling these groundwaters through sludge beds or other methods of contact with relatively uncontaminated sludges followed by isolation and land treatment of the sludge may be a cost-effective means of cleaning contaminated sites. (Doria-PTT) W87-09948

#### 5F. Water Treatment and **Ouality Alteration**

DRINKING-WATER AND SANITATION: WOMEN CAN DO MUCH,

International Reference Centre for Community Water Supply and Sanitation, The Hague (Nether-

#### Group 5F-Water Treatment and Quality Alteration

C. van Wijk-Sijbesma. World Health Forum WHFODN, Vol. 8, No. 1, p 28-32, 1987. 9 ref.

Descriptors: \*Water supply, \*Drinking water, \*Public health, \*Sanitation, Public participation,

In many societies, traditional roles are such that women are well placed to contribute significantly to the success of water supply and sanitation projects. Women can help to ensure that installa-tions function reliably and are adequately used, and that their potential impact on public health and socioeconomic development is realized. National and local planning processes should facilitate and support women's participation. (Author's abstract) W87-09682

## DEVELOPMENT OF A STRATEGY FOR UP-GRADING SMALL RURAL WATER SUPPLIES WITHIN THE BORDERS REGION,

G. R. Swalwell, and P. F. Johnson. Journal of the Institution of Water Engineers and Scientists JIWSDI, Vol. 41, No. 2, p 137-160, April 1987. 4 fig. 5 tab

Descriptors: \*Water resources development, \*Water supply, \*Rural areas, \*Scotland, Management, Policy making, Water demand, Remote sens-

The situation in the Border Region, a rural area in the southeast of Scotland, with respect to small rural water supplies and development of a strategy for improving these supplies is discussed. Quality problems fall into four categories: bacteriological failures (in 1984 19 of the 25 small supplies were unsatisfactory); physical problems; plumbosolvency; and others (e.g., dezincification, algae, taste and odor, none of which are very frequent). The impending implementation of the European Community Directive 80/778/EEC in 1985 provided the impetus to develop a strategy to achieve the required water quality standard on small supplies the impetus to develop a strategy to achieve the required water quality standard on small supplies as well as on larger ones. A group containing representatives of management, operations, new works and the scientific community was formed to review existing levels of service, review broad policy and implementation options, set targets and review progress on each system, and review monireview progress on each system, and review moni-toring arrangements for assessment of water qual-ity. Based on the work of this group, the Borders Regional Council arrived at the following frequen-cy for analytical testing: weekly for total coli-forms, fecal coliforms, plate counts at 22 and 37 C, taste, odor, and residual chlorine; monthly for color, pH, turbidity, alkalinity, total hardness, alu-minum, iron, and conductivity; every four months for temperature, ammonia, nitrates, and nitrites. for temperature, ammonia, nitrates, and nitrites; and annually for what is called 'exhaustive analyfor temperature, ammonia, nitrates, and nitrites; and annually for what is called 'exhaustive analysis', a further 30 parameters. Several supplies have been upgraded by providing improved chlorination, by being absorbed into larger supplies by mains extensions, and some by the abandonment of upland intakes in favor of shallow boreholes. Implementation of the new schemes is illustrated by a description of their application in Heriot and Yarrowford, including the installation of new telemetry equipment and it linking to the Regional Telemetry System, which is designed for monitoring, alarm generation, and, in the future, control purposes. (Peters-PTT)

# DESIGN AND PERFORMANCE OF A COM-MUNITY TYPE IRON REMOVAL PLANT FOR HAND PUMP TUBEWELLS,

Bangladesh Univ. of Engineering and Technology, Dacca. Dept. of Civil Engineering. F. Ahmed, and P. G. Smith.

Journal of the Institution of Water Engineers and Scientists JIWSDI, Vol. 41, No. 2, p 167-172, April 1987, 3 fig. 1 tab, 5 ref.

Descriptors: \*Water treatment, \*Iron removal, \*Tubewells, \*Design standards, \*Groundwater, Drinking water, Aeration, Sedimentation, Adsorption, Bangladesh.

In Bangladesh, groundwater collected through hand pump tubewells is a major source of safe water for drinking and other domestic purposes. This groundwater may have an iron content in excess of 10 mg/L. This paper describes the design and operation of a low cost iron removal plant it is based on aeration, sedimentation, and adsorption of iron precipitates on brick chips. This plant has been installed in over 250 locations in rural Bangla-desh. Field investigations of over 100 of these plants show an iron removal in excess of 90 per cent. (Author's abstract) W87-09708

# INCIDENCE OF STAPHYLOCOCCUS AUREUS, COLIFORMS AND ANTIBIOTIC-RE-SISTANT STRAINS OF ESCHERICHIA COLI IN RURAL WATER SUPPLIES IN PORT HAR-

COURT, Rivers State Univ. of Science and Technology, Port Harcourt (Nigeria). Microbiology Div.

Journal of Applied Bacteriology JABAA4, Vol. 62, No. 4, p 371-375, April 1987. 5 tab, 21 ref.

Descriptors: \*Pollutant identification, \*Water supply, \*Bacteriology, \*Water quality, \*Coliforms, \*Staphylococcus, Antibiotics, Isolation, Bacteria.

The bacteriological quality of some rural water supplies in Port Harcourt was monitored over a 3 month period. The supplies were unsatisfactory as judged by standard plate counts (1000/ml) and the presence of presumptive and fecal coliforms and Staphylococcus aureus. The recovery of potential-Staphylococcus aureus. The recovery of potential-ly pathogenic bacteria (e.g. Pseudomonas aerugin-osa) further substantiated the existence of health hazards. The most frequently isolated coliforms were Escherichia coli, Enterobacter aerogenes and Klebsiella pneumoniae. Coliform contamination was greater in well water than in river or stream water samples. An antibiotic sensitivity test re-vealed that 17.5-27.2% of E. coli strains were resistant to three or more antibiotics. Escherichia coli isolated from well water samples ethibited the coli isolated from well water samples exhibited the greatest degree of multiple resistance. Some strains greatest degree or multiple reassuance. Some strains were resistant to all the six antibiotics tested. The danger of an epidemic of waterborne diseases in the communities as a result of drinking water from these non-potable sources is noted. (Author's abstract) W87-09711

### DESULFATION OF BRACKISH WATER BY ION EXCHANGE FOR CALCIUM SULFATE

SCALE CONTROL.
Foster-Miller, Inc., Waltham, MA.
For primary bibliographic entry see Field 3C.
W87-09773

#### MICROBIOLOGICAL CLEANUP OF PENTACHLOROPHENOL-CONTAMINATED GROUNDWATER

BioTrol, Chaska, MN.

Bio Iroi, Chaska, MN.
T. D. Frick, and R. L. Crawford.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB87-177275/
AS. Price codes: A03 in paper copy, A01 in microfiche. Final Report, December 1986. 30 p., 12 fig., 1
tab, 20 ref. USGS Contract No. 14-08-0001-01139.

Descriptors: \*Water treatment, \*Groundwater, \*Chlorinated hydrocarbons, \*Biotreatment, \*Pentachlorophenol, Bioreactor, Groundwater contamination, Feasibility studies.

This study demonstrated the feasibility of microbiological cleanup of pentachlorophenol-contaminated groundwater. A 200 liter packed bed bioreactor was constructed and colonized with a microbial consortia which degrade the pentachlorophenol. This bioreactor effectively removed more than 99 percent of the pentachlorophenol from groundwater, beneath a wood treating facility. groundwater beneath a wood treating facility which contained 60 to 80 ppm of pentachlorophenol. The overall activity of the bioreactor reached 60 mg of pentachlorophenol consumed per hour per liter of reactor volume. In addition to pentachlorophenol, the bioreactor removed a number of non-target compounds. The chemical oxygen demand of the water was reduced from 270 mg per liter in the influent to 190 mg per liter in the effluent. Initial cost estimates indicated that this technology will be competitive with activated charcoal treatment. (USGS)

ULTRA-HIGH LIME TREATMENT OF RECY-CLED COOLING WATER, Texas A and M Univ., College Station. Dept. of Civil Engineering. B. Batchelor, M. Burnett, M. McDevitt, and E.

B. Battenetor, M. Butter, Peacock.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-177309/
AS. Price codes: A09 in paper copy, A01 in microfiche. Technical Completion Report, August 1986.
181 p, 60 fig. 11 tab, 64 ref, 5 append. USGS Contract No. 14-08-0001-G1055.

Descriptors: \*Silica, \*Water treatment, \*Cooling water, \*Recycling, \*Lime treatment, Scaling, Silicates, Water softening, Kinetics, Recirculated water, Chemical treatment.

water, Chemical treatment.

Recycling cooling water is a primary method for extending existing water supplies and is often limited by formation of silica scales. A series of experiments was conducted to evaluate the technical and economic feasibility of the ultra-high lime process for removing silica from recycled cooling water. These experiments used a bench scale continuous flow reactor system with automatic control of reactor pH and flow. Experiments were conducted over a range of values of pH (pH 10.9 to pH 12.1), temperature (25, 35, and 45 C), hydraulic retention time (2 to 64 minutes), and solid retention time (2 to 425 minutes). Results of these experiments showed that the ultra-high lime process is technically and economically feasible. Good silica removal was observed at hydraulic and solid retention times below those typically employed in conmoval was observed at hydraulic and solid reten-tion times below those typically employed in con-ventional lime softeners. The solids produced in the ultra-high lime process had settling characteris-tics similar to those found in conventional soften-ers. The particle size distribution of the calcium silicate solids produced in the ultra-high lime procsincate soins produced in the ultra-night inne process was measured with a settling column procedure. Information from the particle size distributions was used to develop a kinetic silica removal. An economic comparison of the ultra-high lime process and conventional lime softening was performed using a cooling system simulation model and cost equations for water treatment processes. This analysis showed that the ultra-high lime proc-Inis analysis showed that the ultra-nigh inme proc-ess applied in the combined treatment configura-tion was more economical than the conventional lime softening in the combined, sidestream, and make-up configurations. The economical advan-tage of the ultra-high lime process increased as the degree of recycle increased or the concentration of scalants in the make-up water increased. (USGS) W87-09775

# CADMIUM REMOVAL AND RECOVERY BY MAGNESIUM CEMENTATION, Georgia Inst. of Tech., Atlanta. School of Civil Engineering.

Engineering.
For primary bibliographic entry see Field 5D.
W87-09778

# HYDRAULIC DESIGN ALGORITHMS FOR UPGRADING AND ENHANCING WATER DISTRIBUTION SYSTEMS,

Kentucky Water Resources Research Inst., Lex-

ington.
D. J. Wood, and W. Gilbert.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB87-159364/
AS. Price codes: AOS in paper copy, AOI in microfiche. Report No. 165, Aug. 1986. 79 p, 60 fig. 19
tab, 30 ref, 3 append. Contract No. 14-08-0001G908; 14-08-0001-G10190. USGS Project No.
G908-08; G1019-08.

Descriptors: \*Water distribution, \*Pipe flow, \*Computer programs, Water transport, Design cri-

Algorithms were developed for directly determin-ing design characteristics for effectively enhanc-

Water Quality Control-Group 5G

ing, modifying, or adding to existing water distribution systems. This is accomplished by modifying the basic hydraulic network equations to explicitly determine required design parameters to just meet specified conditions. Initially work was completed on directly determining pipeline adn network resistance characteristics. This work was published in technical journals and established the feasibility of the approach but did not demonstrate the scope and versitility of the proposed approach. In this report a general approach is developed and tested to demonstrate the wide range of capabilities possible. Numerous examples are presented which illustrate the scope of calculations possible and demonstrate the solity of the approach to meet the objectives. (Huffsey-KWRRI)

DESCRIPTION OF WATER-SYSTEMS OPERATIONS IN THE ARKANSAS RIVER BASIN, COLORADO,

Geological Survey, Pueblo, CO. Water Resources

P. O. Abbott.

P. U. Abbott. Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 85-4092, 1985. 67 p, 27 fig, 5 tab, 16 ref.

Descriptors: \*Water supply systems, \*Municipal water, \*Irrigation water, \*Industrial water, \*Arkansas River, \*Colorado, Multi-purpose projects.

To facilitate a current project modeling the hydrology of the Arkansas River basin in Colorado, a description of the regulation of water in the basin is necessary. The geographic and climatic setting of the Arkansas River basin that necessitates the use, reuse, importation, and storage of water are discussed. The history of water-resource development in the basin, leading to the present complex of water systems, also is discussed. Municipal, irrigation, industrial, and multipurpose water systems are described. System descriptions are illustrated with schematic line drawings, and supplemented with physical data tables for the lakes, tunnels, conduits, and canals in the various systems. Copies of criteria under which certain of the water systems operate, are included. (USGS)

PROPOSED APPLICATION OF AUTOMATED BIOMONITORING FOR RAPID DETECTION OF TOXIC SUBSTANCES IN WATER SUP-PLIES FOR PERMANENT SPACE STATIONS, Tennessee Technological Univ., Cookeville. For primary bibliographic entry see Field 7B. W87-09925

NEW APPLICATION FOR A TRIED TECH-

NEW APPLICATION FOR A SALED ASSOCIATION OF THE PROPERTY OF T

Descriptors: "Water treatment, "Ion exchange, "Water quality management, "Resins, "Water quality, Uranium radioisotopes, Isotope studies, Radioisotopes, Groundwater pollution, Drinking water, Wells, Colorado, Anion exchange.

weis, Colorado, Anion exchange.

A school water supply in Colorado was found to be contaminated by radioactive uranium isotopes; testing in 1979 revealed gross-alpha activity in the well water as high as 20 piccouries/liter (pCi/L). Though the maximum contaminant level had not been set by the US Environmental Protection Agency, 10 pCi/l was considered a cautious upper-level for allowable contamination by uranium in drinking water. Because ion-exchange techniques had previously been used to reclaim uranium from mining process waters, a strong base anion-exchange resin, IONAC A641 from Sybron Chemicals, Inc., was tested in a pilot study. The apparatus, consisting of a pumping and prefiltration stage followed by the ion-exchange columns, was then constructed for the school. Virtually all uranium from the well water is removed by the exchange columns. Alternatives for the disposal of the radio-

active brine were presented. It is expected that this application of a tried technology will be used to purify small wells and larger water flows containing undesirable uranium isotopes. (Wood-PTT) W87-09937

EFFECTIVE WATER TREATMENT IN INDUSTRIAL PLANTS,
Culligan International Co., Northbrook, IL.
W. C. Traka.

Consulting-Specifying Engineer, Vol. 1, No. 4, p 99-100, April 1987.

Descriptors: \*Water quality control, \*Water treatment, \*Quality control, \*Industrial water, Water use, Industrial plants, Raw water, Water quality standards, Standards, Water softening, Filtration, Osmosis, Deionization, Sterilization, Economic as-

A system's approach to managing an industrial facility's total water needs was described. First, the quality of the raw water supply must be examined by testing for total dissolved mineral salts, dissolved or colloidal silica, organic and biological matter, colloidal materials and other impurities. An engineer must then identify the water quality requirements for various applications at the site. Finally, the engineer must select appropriate systems and services to meet the requirements. Water treatment options including water softening, depth filtration, carbon filtration, reverse comosis, deionization, ultraviolet sterilization, and submicron filtration were described. Differences in raw water, as well as in an operation's purpose, size and struction were described. Differences in raw water, as well as in an operation's purpose, size and structure, affect how water is used and which of the treatment options are needed. Careful economic analysis is necessary for each application to optimize the water treatment process and improve the industrial product quality and plant efficiency. (Wood-PTT) W87-09940

METHODOLOGY FOR OPTIMAL DESIGN OF PIPE DISTRIBUTION NETWORKS, Ottawa Univ. (Ontario). Dept. of Civil Engineer-

ing. A. N. El-Bahrawy, and A. A. Smith.
Canadian Journal of Civil Engineering CJCEB8,
Vol. 14, No. 2, p 207-215, April 1987. 7 fig. 7 tab,

Descriptors: \*Network design, \*MINOS, \*Data interpretation, \*Design criteria, \*Pipelines, \*Distribution networks, \*Computer programs, Automation, Discretization.

A series of computer programs has been developed to assist in the optimal design of pipe distribution networks. These programs are capable of handling nonstandard network components such as booster pumps, minor-loss devices, reservoirs, check valves, and pressure-reducing valves. All three stages of network problem, namely analysis, design, and optimization, can be solved using the same solution procedure. A known technique for layout design has been adapted to help in the slection of redundant links. The problem is formulated as a nonlinear program using as design variables the diameter, discharge, and shutoff head (where appropriate) for each link. Pump lift is assumed to be described by a parabolic Q - h sub p curve, the coefficients of which may be defined by MINOS is used to solve the problem. The continuous solution obtained by MINOS is modified by a discretization procedure to arrive at the optimal discrete solution. The constraint matrix including the loop, nodal head, and continuity constraints is automatically generated. The user is required to supply a simple and concise data file that will be interfaced by a preprocessor to generate the large and complicated data file required by MINOS. The latter data file includes the nonzero elements of the constraint matrix, ordered and stored in a column-by-column fashion. A postprocessor is also used to convert the mathematical output of the package into easily matrix, ordered and stored in a column-by-column fashion. A postprocessor is also used to convert the mathematical output of the package into easily understood engineering data. Three different network examples are used to demonstrate the different aspects of the model (i.e., nonstandard compo-

nents, discretization procedure, and layout design). (Author's abstract) W87-10106

MODIFICATIONS TO THE DESIGN PROCE-DURE FOR GRIT CHAMBERS, For primary bibliographic entry see Field 8A W87-10107

#### 5G. Water Quality Control

GROUNDWATER PROTECTION. Conservation Foundation, Washington, DC. For primary bibliographic entry see Field 4B. W87-09621

PROCESS MODIFICATIONS FOR INDUSTRI-AL POLLUTION SOURCE REDUCTION, Illinois Inst. of Tech., Chicago. Pritzker Dept. of Environmental Engineering. L. L. Tavlarides.

Industrial Waste Management Series. Lewis Publishers, Inc., Chelsea, MI. 1985. 150 p. James W. Patterson, Series Editor.

Descriptors: \*Process control, \*Process modifica-tion, \*Industrial wastes, \*Water pollution control, \*Water pollution prevention, Metals, Electroplat-ing, Pulp and paper industry, Fertilizers.

The objective of this project on process modifica-The objective of this project on process modifica-tions for pollution source reduction in the chemical processing industries is to identify potential changes in manufacturing processes which could have significant impact on pollution elimination or reduction at its source. Toward this end, eight reduction at its source. Toward this end, eight industries were evaluated to develop a matrix of significant pollution problems and attendant process modifications which would have impact on the reduction or elimination of pollutants inherent in these processes. The industries evaluated are as follows: (1) Refining of Nonferrous Metals; (2) The Electroplating Industry; (3) Coal Conversion Processes; (4) Specialty Chemicals; (5) The Iron and Steel Industry; (6) The Pulp and Paper Industry; (7) The Primary Aluminum Industry; and (8) Phosphate Fertilizer Industry. Although these industries are diverse, it has become apparent through this study that generic pollution problems cut across most of these and other industries not covered in the study. Accordingly, various process across most of these and other industries not cov-ered in the study. Accordingly, various process modification strategies and attendant research pro-grams which would minimize these pollution prob-lems and are generic in nature, are identified. (Lantz-PTT) W87-09629

SELECT: A NUMERICAL, ONE-DIMENSION-AL MODEL FOR SELECTIVE WITHDRAWAL, Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab. J. E. Davis, J. P. Holland, M. L. Schneider, and S.

Available from the National Technical Information Service, Springfield, Virginia 22161. Instruction Report E-87-2, March 1987. Final Report. 179 p, 28 fig. 12 tab, 10 ref, 5 append.

Descriptors: \*Water quality control, \*SELECT, \*Computer programs, \*Selective withdrawal, \*Model studies, \*Reservoir operation, Discharge, Dissolved oxygen, Turbidity, Temperature, Mathematical stud

The SELECT program is a one-dimensional numerical model that predicts the vertical extent and distribution of withdrawal from a reservoir of known density and quality distribution for a given discharge from a specified location. Using this prediction for the withdrawal zone, SELECT computes the quality of the release for user-specified parameters (such as temperature, dissolved oxygen (DO), turbidity, iron) treated as conservative substances. The release constituents are contive substances. The release constituents are con-sidered conservative through the selective withdrawal structure because the detention time in the structure is short compared with the time required for the constituents to physically or chemically

#### Group 5G-Water Quality Control

change. For example, there would be no time for the water temperature to change significantly nor would there be time for iron to oxidize significantly. SELECT will predict, however, the improvement in DO that would occur due either to natural reaeration, as flow passes through gated-conduit outlet works, or to turbine venting. The purpose of this report is to document the updated version of this report is to occument the updated version of the SELECT program for field office use. This is done by describing the computational methodologies and the sequence of operations in SELECT (Part II), the operations used in the subprograms (Part III), and the assumptions and limitations inherent to the code (Part IV). Definitions of the data required as input are provided in Part V. (Lantz-PTT) W87-09631

HISTORY AND APPLICATION OF MICRO-BIOLOGICAL WATER QUALITY STANDARDS IN THE MARINE ENVIRONMENT,

Pan American Center for Sanitary Engineering and Environmental Sciences, Lima (Peru). H. J. Salas.

Water Science and Technology WSTED4, Vol. 18, No. 11, p 47-57, 1986. 1 fig, 2 tab, 34 ref.

Descriptors: "Water quality standards, "Recreation, "Bioindicators, "Swimming, Coastal waters, Feces, Coliforms, Water quality, Public health,

The history and application of microbiological water quality standards in the marine environment water quality standards in the internet elevation that for primary contact recreation and shellfish har-vesting are presented. Special note is taken of recent investigations which concluded that Enterococci, as an indicator organism, provided the best correlation with gastrointestinal symptoms attributed to swimming in contaminated waters. The linear relationship developed between mean enter-ococcus density per 100 ml and swimming associated associated as the control of the control ococcus density per 100 ml and swimming associated rate for gastrointestinal symptoms per 1000 persons is presented along with the US Environmental Protection Agency proposal to adopt Enterococci as the primary indicator organism in lieu of total and fecal coliforms. One school of thought which considers microbiological guidelines/standwhich considers incromological guidenties/standards for primary contact recreation relevant to public health protection is compared to the opposing viewpoint that such guidelines/standards are merely useful for aesthetic considerations. International, national and local microbiological guidelines and standards in the marine environment are lines and standards in the marine environment are presented to provide a range for the water quality planner. The simple adaptation of a particular set of standards is considered inappropriate without a thorough review of local circumstances and local/national economic factors. Also, caution should be exercised in directly applying quantitative relationships between health risk and indicator organism in other areas where the general health and immunity of the local consultation was be different (Author). of the local population may be different. (Author' abstract) W87-09637

MEETING THE WATER QUALITY CRITERIA FOR THE METAL FINISHING INDUSTRIES, Texas Instruments, Inc., Attleboro, MA. For primary bibliographic entry see Field 5D. W87-09656

INTERCEPTOR TRENCHES FOR POSITIVE GROUND WATER CONTROL,

Union Carbide Corp., Port Lavaca, TX. Polyofins

For primary bibliographic entry see Field 5B. W87-09669

GROUNDWATER RESOURCE ASSESSMENT AND MANAGEMENT RECOMMENDATIONS FOR OUTAGAMIE COUNTY, WISCONSIN, Fox Valley Water Quality Planning Agency, Menasha, WI.

For primary bibliographic entry see Field 4B.

GAPS, CONFLICTS, OVERLAPS, AND INCON-SISTENCIES IN TENNESSEE'S ENVIRON-MENTAL LAWS AND REGULATIONS,

Vanderbit Univ., Nashville, TN. Dept. of Civil and Environmental Engineering.

For primary bibliographic entry see Field 6E.

W87-09746

TRANSFER OF INFORMATION AMONG WATER QUALITY VARIABLES OF THE POTOMAC RIVER, PHASE III: TRANSFERABLE AND TRANSFERRED INFORMATION,

George Washington Univ., Washington, DC. International Water Resources Inst. For primary bibliographic entry see Field 7C.

LONG-TERM EFFECTIVENESS AND MAIN-TENANCE OF VEGETATIVE FILTER STRIPS, Virginia Polytechnic Inst. and State Univ., Blacks-burg. Dept. of Agricultural Engineering. T. A. Dillaha, J. H. Sherrard, and D. Lee 1. A. Duiana, J. H. Sherrard, and D. Lee. Available from the National Technical Information Service, Springfield, VA 22161, as PB87-176251/ AS. Price codes: A03 in paper copy, A01 in micro-fiche. Virginia Water Resources Research Center, Blacksburg. Bulletin 153, December 1986. 39 p, 2 fig, 2 tab, 28 ref.

Descriptors: \*Vegetative filter strips, \*Buffer strips, \*Vegetative filters, \*Nonpoint-source pollution, \*Water pollution control, Sediment transport, Deposition, Nutrient removal, Water quality.

Vegetative filter strips (VFS) on 33 Virginia farms were visited and observed over a 13-month period to evaluate their long-term effectiveness for water to evaluate their long-term effectiveness for water quality improvement. Operational problems observed during the site visits were documented and design or maintenance procedures to alleviate the problems were evaluated. Of the VFS observed, 36% were judged to be totally ineffective, were no longer in existence or were significant. Solve were judged to be totally interestive, where no longer in existence, or were simply extensions of pastures – although all were, or had been, part of the state cost-share program. Most of the sites visited had topographic limitations which severely visited and topographic limitations which severely limited VFS performance. Accumulation of sur-face runoff in natural drainageways within fields before it reached the VFS was the most critical problem. Runoff from the drainageways crossed the VFS in a few narrow areas, totally inundating the filters and rendering them ineffective for sediment and nutrient reduction. This situation is difficult to control and VFS are probably not appropriate for fields with extensive internal drainageways unless the VFS extend up into the fields and parallel the drainageways forming wide grassed water-ways. Vegetative filter strips were judged to be beneficial even when they could not filter sediment and nutrients from runoff because they provided localized erosion protection in critical areas along streambanks. They did not act as filters, however, and should therefore be referred to as vegetative buffer strips or critical area plantings. (USGS) W87-09752

OPTIMIZATION OF RECREATIONAL PO-TENTIAL IN NUTRIENT-ENRICHED LAKES BY CONTROL OF FISH POPULATIONS. Michigan State Univ., East Lansing. Dept. of Fish-

eries and Wildlife. For primary bibliographic entry see Field 5C. W87-09756

FLOW THROUGH CLAY LINERS: MODEL PREDICTION AND FIELD OBSERVATION. Wayne State Univ., Detroit, MI. Dept. of Civil

neering Engineering C. J. Miller.

C. J. Miller.

Available from the National Technical Information Service, Springfield, VA 22161, as PB87-172664/
AS. Price codes: A04 in paper copy, A01 in microfiche. Michigan Water Research Institute, East Lansing, Michigan. Publication No. G1024-02, June 1986. 60 p. 15 fig, 3 tab, 20 ref, 2 append. Contract No. 14-08-0001-G1024. USGS Project No. G1024-02.

Descriptors: \*Landfills, \*Liners, \*Hazardous wastes, \*Groundwater pollution, Elays, Numerical wastes, \*Ground models, Seepage.

Low permeability liners are typically constructed above hazardous waste landfills to impede the movement of moisture into the waste, thereby removement of moisture into the waste, thereby reducing the volume of moisture available for leachate generation. Leachate is a potential source of groundwater contamination. Thus, the concern for adequately designed cover liners. One of the primary parameters which must be estimated when assessing the adequacy of a particular liner design is the expected liner leakage. However, present approaches to this prediction neglect many critical aspects of the problem and have not been verified with field measurements. The present report addresses this problem using a numerical model of dresses this problem using a numerical model of the general landfill cover liner problem and data of moisture profiles within the cover liner of a proto-type landfill. The numerical model requires usertype landfill. The numerical model requires usersupplied input to characterize the prototype landfill conditions: precipitation records, liner geometry, liner material properties, and appropriate initial and boundary conditions. The model output
includes time-dependent leakage rates, cumulative
leakage volumes, and moisture profiles for the liner
material. The field data of moisture profiles are
available for a seven month period. The data is
compared to the site precipitation history and expected leakage conditions. (USGS)
W87-09760

REDUCTION OF NITRATE LEACHING LOSSES BY COMPUTERIZED NITROGEN AND IRRIGATION WATER SCHEDULING

AND IRRIGATION WATER SCHEDULING FOR CORN, Michigan State Univ., East Lansing. Dept. of Crop and Soil Sciences. B. G. Ellis, T. Louden, and J. T. Ritchie.

Available from the National Technical Information Service, Springfield, VA 22161, as PB87-172623/ AS. Price codes: A03 in paper copy, A01 in micro-fiche. Michigan Water Research Institute, East Lansing, Michigan. Publication No. G1024-03, June 1986. 42 p, 4 fig, 14 tab, 3 ref. Contract No. 14-08-0001-G1024. USGS Project No. G1024-03.

Descriptors: \*Nitrate leaching, \*Nitrogen scheduling, \*Irrigation scheduling, \*Irrigation design, Contamination, Model studies, Corn, CERES-Maize model

This one year study showed that the CERES-Maize model for irrigation and nitrogen scheduling is a management tool that may be developed for practical use either by individual farmers or by advisory personnel who offer this service to farmers. The model predicted well the yield of irrigated field corn but not for irrigated seed corn. Additional work to validate the model for seed corn (and other crops) will be necessary. The model predicts other crops) will be necessary. The model predict-ed ammonium levels in the soil profile rather well, but underestimated the nitrate levels. The degree of agreement was sufficiently close to suggest that further validation and adjustment of the model would be desireable and not too difficult to accomplish. But the data showed that the degree of nitrate leaching from the profile would be reduced through nitrogen scheduling without measurable loss of yield. Modifications in the CERES-Maize model were made that made it more user friendly so that it can easily be run by a farmer on a microcomputer. The cost of the computer necessary to accomplish this is less than \$2,000 and is already a part of many farm operations. (USGS) W87-09761

FUTURE DRINKING WATER - STATE AND LOCAL POLICIES FOR PROTECTING FUTURE DRINKING WATER RESERVOIR SITES AND WATERSHEDS IN NORTH CARO-

North Carolina Univ. at Chapel Hill. Center for

Norm Carolina Only at Chaper Hill. Center for Urban and Regional Studies.

R. J. Burby, D. J. Brower, and D. Whittington.

Available from the National Technical Information Service, Springfield, VA 22161, as PB86-170412/

AS. Price codes: A07 in paper copy, A01 in microfiche. North Carolina Water Resources Research Inst., Raleigh, NC. Completion Report No. 222,

#### WATER RESOURCES PLANNING—Field 6

December 1985. 126p, 2 fig, 8 tab, 89 ref. Contract No. 14-08-001-G-924. USGS Proj. No. G-924-03.

Descriptors: \*Watersheds, \*Drinking water, \*Legal aspects, \*Policy making, \*North Carolina, Land use, Reservoir sites, Water supply, Nonpoint

High quality drinking water is essential to maintain the health and well-being of the citizens of North Carolina and is a critical ingredient in future economic growth. Drinking water supplies needed to meet those needs, however, can no longer be taken for granted. This report examines threats to future drinking water sources from urban expansion and agricultural practices in North Carolina. It documents current exclusive and programs desired by agricultural practices in North Carolina. It docu-ments current policies and programs adapted by local governments to protect potential drinking water supplies. Finding those policies inadequate, it examines a broad range of state programs that could be used to preserve future reservoir sites and protect water quality in watersheds that might be used in the future as drinking water sources. A panel of state and local officials rated the effective-WRRI W87-09764

BIOLOGICAL REMOVAL OF CHLORINATED HYDROCARBONS FROM WATER,

Louisiana State Univ., Baton Rouge. Inst. for Environmental Studies

For primary bibliographic entry see Field 5D. W87-09769

DEVELOPMENT OF CONFIDENCE INTER-VALS AND MONTHLY DESIGN VALUES FOR LOW STREAMFLOWS,

Georgia Univ., Athens. Dept. of Statistics and Computer Science.
For primary bibliographic entry see Field 2E.
W87-09779

PERFORMANCE EVALUATION OF A DETEN-TION BASIN AND COALESCING PLATE OIL SEPARATOR FOR TREATING URBAN STORMWATER RUNOFF, Washington Univ., Seattle. Dept. of Civil Engi-

For primary bibliographic entry see Field 5D. W87-09796

INFLUENCE OF POTASSIUM MINING IN CA-INFLUENCE OF POIASSIUM MINING IN CA-TALONIA ON THE QUALITY OF THE WATER OF THE LLOBREGAT RIVER (BARCELONA) (INFLUENCIA DE LA MINERIA POTASICA CATALANA EN LA CALIDAD DEL AGUA DEL

RIO LLOBREGAT (BARCELONA)), Comisaria de Aguas del Pirineo Oriental, Barcelo-

For primary bibliographic entry see Field 5B. W87-09886

WATER IN THE MINING OF SOFT COAL, A STUDY OF A PILOT AREA (EL AGUA EN LA MINERIA DE LA HULLA, ESTUDIO DE UNA

MINERIA DE LA HULLA, ESTUDIO DE UNA ZONA PILOTO), Empresa Nacional Adaro de Investigaciones Min-eras S.A., Madrid (Spain). For primary bibliographic entry see Field 5B. W87-09887

CONTROL AND DRAINAGE OF WATER IN MINE TAILINGS DAMS,

Carleton Univ., Ottawa (Ontario). Dept. of Civil Engineering.

IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol-umes I and II, 1984. SIAMOS 78. p 1125-1137, 6

Descriptors: \*Water quality control, \*Mine wastes, \*Waste disposal, \*Hydraulic structures, \*Dams, Dam stability, Canada, Economic aspects, Costs, Industrial wastes, Drainage, Water pollution control, Monitoring, Design criteria.

Mining is one of the largest industries in Canada. The costs of controlling water in tailings structures represents a major share of the total cost of tailings disposal. Furthermore, the control and drainage system adopted will have an influence on the stability of the dam and on the pollution potential of the environment. Monitoring of water pressures and water flow within these structures will supply valuable records during construction and for future design considerations. (Author's abstract) W87-09894

MARINE POLLUTION AND COUNTERMEAS-URES IN JAPAN,

Environment Agency, Tokyo (Japan). Water Qual-For primary bibliographic entry see Field 5B. W87-09932

PLANNING FOR THE FUTURE, Pirnie (Malcolm), Inc., White Plains, NY. For primary bibliographic entry see Field 6D. W87-09932

PUTTING THE GROUNDWATER MONITOR-ING PIECES TOGETHER, Pirnie (Malcolm), Inc., White Plains, NY. D. K. Cohen, and S. A. Smiriglio.

Water Engineering and Management WENMD2, Vol. 134, No. 2, p 24-26, February 1987. 4 fig.

Descriptors: \*Groundwater monitoring, \*Water quality management, \*Groundwater management, \*Monitoring wells, \*Groundwater, Water management, Drinking water, Safe Drinking Water Act, Legislation, Monitoring, Wells, Construction materials, Measuring instruments, Groundwater pollution, Groundwater level.

New amendments to the Safe Drinking Water Act of June 1986 call for a significant increase in the pace of groundwater monitoring activities. The US Environmental Protection Agency is required to identify additional monitoring methods to enable early detection of contamination. States will be required to assume responsibility for monitoring and to establish wellhead protection areas. The design of monitoring wells was reviewed and the recent changes in the materials used for their construction were detailed. New technologies which have simplified groundwater level measurement and increased the accuracy of groundwater quality measurements were presented. (Wood-PTT) W87-09936 New amendments to the Safe Drinking Water Act

NEW APPLICATION FOR A TRIED TECHNOLOGY.

Arber (Richard P.) Associates, Inc., Denver, CO. For primary bibliographic entry see Field 5F. W87-09937

BIOLOGICAL TESTING TO CONTROL TOXIC WATER POLLUTANTS,

Environmental Protection Agency, Washington, DC. Office of Water Enforcement. For primary bibliographic entry see Field 5A. W87-09944

LANDSAT DATA F
PERMIT MONITORING. FOR REGULATORY

Army Engineer Waterways Experiment Station, Vicksburg, MS. For primary bibliographic entry see Field 7B. W87-0992

USE OF PEAT IN WATER POLLUTION CONTROL: A REVIEW,
T. Viraraghavan, and A. Ayyaswami.
Canadian Journal of Civil Engineering CJCEB8,
Vol. 14, No. 2, p 230-233, April 1987. 2 tab, 35 ref.

Techniques Of Planning-Group 6A

Descriptors: \*Peat, \*Literature reviews, \*Pollution control, \*Wastewater treatment, Water treatment, Water quality.

Peat, besides being plentiful and inexpensive, pos-sesses several other qualities that make it an effec-tive medium for the removal of pollutants. This paper presents a review of its use in water pollu-tion control - in the treatment of sanitary and industrial wastewaters. (Author's abstract) W87-10109

#### 6. WATER RESOURCES PLANNING

#### 6A. Techniques Of Planning

RECENT ASPECTS OF STUDY METHODS OF DRAINAGE OF OPEN PITS EXCAVATIONS (ASPECTS RECENTS DES METHODES D'ETUDE DU DRAINAGE DES MINES A CIEL

Bureau de Recherches Geologiques et Minieres,

Bureau de Recherches Geologiques et Minieres, Orleans (France). B. Feuga, and R. Pasquet. IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterrancos), Vol-umes I, 1984. SIAMOS 78. p 603-618, 2 fig, 4 ref.

Descriptors: \*Mine drainage, \*Groundwater movement, \*Hydrologic data collections, Core drilling, Drainage engineering, Geohydrology, Hydrologic models, Project planning, Piezometers,

Studies of open pit mine drainage may be made during project planning or when the stability of the mine is threatened. In the latter case, the urgency of the situation makes it necessary to utilize rapid study techniques so that the range of available means is somewhat reduced. Geohydrological surmeans is somewhat reduced. Geonydrological sur-veys are the starting point for all drainage studies. Point piezometers are used for this phase. A geo-logical study is carried out by sampling surface outcrops and mine reconnaissance galleries or by core drilling. A computerized data processing method has been developed making it possible to method has been developed making it possible to determine the orientation of the main permeabilities of the medium and their relative values. Lastly, the absolute value for terrain permeabilities is determined by in situ tests in the simplest manner possible. This body of data is used for a simulation model for groundwater flow around the pit. The model can be numerical or an analog model. In practice, it is rarely possible to apply completely this ideal study pattern. The greatest attention should be given to the collection of all available data and a careful interpretation of this data. See data and a careful interpretation of this data. (See also W87-09568) (Geiger-PTT) W87-09605

GROUNDWATER MANAGEMENT: THE USE OF NUMERICAL MODELS, Butler Univ., Indianapolis, IN. Holcomb Research

For primary bibliographic entry see Field 4B. W87-09623 Inst.

INSTANTANEOUS UNIT HYDROGRAPHS: A GEOMORPHOLOGIC APPROACH,
Georgia Inst. of Tech., Atlanta. School of Civil

Engineering. For primary bibliographic entry see Field 4A. W87-09777

SYSTEM COOPERATION IN REGIONAL WATER SUPPLY PLANNING, Washington Univ., Seattle. Dept. of Civil Engi-

neering.
For primary bibliographic entry see Field 6E.
W87-09798

IRRIGATED AGRICULTURAL STRATEGIES FOR VARIABLE DECISION VARIABLE WEATHER CONDITIONS.

Mexico State Univ., Las Cruces. Dept. of

#### Field 6-WATER RESOURCES PLANNING

#### Group 6A-Techniques Of Planning

Agricultural Economics and Agricultural Business. For primary bibliographic entry see Field 3F. W87-09800

#### 6B. Evaluation Process

WATER AND THE MICHIGAN ECONOMY: ESTIMATING THE ECONOMIC VALUE OF MICHIGAN'S FRESH WATER,

Michigan State Univ., East Lansing. Dept. of Agri-cultural Economics.

For primary bibliographic entry see Field 6C. W87-09763

METHOD FOR IDENTIFYING WATER RE-SOURCES RESEARCH NEEDS AND SETTING PRIORITIES AMONG THEM.

Tennessee Univ., Knoxville. Water Resources Re-

search Center. W. F. Brandes.

W. F. Brandes.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-167640.
AS. Price codes: Al9 in paper copy, A01 in microfiche. Research Report No. 105, November 1985.
426 p. 33 fig. 180 ref. 6 append. Contract No. 14-34-0001-8135 and 1489. USGS Project No. B-038 and C-10144-G.

Descriptors: \*Research priorities, \*Analytical techniques, \*Tennessee, \*Water research management, Research and development, Water resources

The objective was to test a series of procedures to The objective was to test a series of procedures to identify and prioritize the water research needs of a state. A method was sought that would: (1) be understandable to decision-makers, (2) combine subjective judgement with the discipline of a structured approach, (3) be sufficiently discriminatory to limit the number of selections and (4) achieve consensus among interest groups. There were four stages. First four open conferences were held in cities across the state. Second a directed survey. stages. First four open conferences were near in cities across the state. Second, a directed survey was conducted by mail-out questionnaires. Third, the water problems thus identified were translated into researchable topics by a series of 'elite' interviews. Fourth, the potential researchable topics were prioritized by three independent methods: the expert Panel/Nominal Group Technique, the Delphi procedure, and Interpretive Structural Modeling. Participants in the interviews and the prioritizing phases were selected from a common matrix in each case to provide a representative distribution of fields of expertise and institutional distribution of neuros of expertise and institutional affiliations. Substantial concordance between separate panels using different prioritizing approaches provides a high level of confidence in the overall effectiveness of the method. (Brandes-Univ. of Tenn.) W87-09772

EVALUATION OF USER CHARGES TO FI-NANCE WATER SERVICES, Georgia Univ., Athens. Inst. of Natural Resources. For primary bibliographic entry see Field 6C. W87.09780

MODEL FOR ASSESSING THE VISUAL RE-SOURCES OF RIVER BASINS AS AN AID TO MAKING LANDUSE PLANNING DECISIONS, Kentucky Water Resources Research Inst., Lex

ington. T. J. Nieman, D. S. Meshako, D. Walters, M. M. Davis, and C. C. Elliot.

Available from the National Technical Information Service, Springfield, VA 22161, as PB87-159372/ AS. Price codes: A06 in paper copy, A01 in micro-fiche. Report No. 166, July 1986. 98 p. 29 fig. 5 tab, 45 ref. Contract No. 14-08-0001-G908; 14-08-0001-G1019. USGS Project No. G908-04; G1019-04.

Descriptors: \*Land use, \*Water resources development, \*Esthetics, \*Planning, Model studies, Decision making, Water policy.

The visual quality of a river basin and its associated properties can be identified, evaluated and integrated into the landscape planning process. The

model developed provides a quantitative methodology for determining visual quality on the basis of available Geographic Information System factors. These factors are utilized to develop the preference attributes, Color, Form, Texture and Line, which are associated with the assessment of visual which are associated with the assessment of visual quality. The preference attributes are then combined through a decision making process into a continuum of Distinctive, Good, Average and Minimal visual quality and is expressed digitally in map format. By providing visual quality information in a digital format it can be treated as a discrete component of the planning process similar to physical, cultural and economic attributes. (Huffsey-Univ. of KY, WRRI) W87-09789

ECONOMIC IMPACT OF WATER MANAGEMENT STRATEGY FOR WATER SURPLUS AREAS WITH GROUND WATER OVERDRAFT

Mississippi State Univ., Mississippi State. Div. of Business Research. L. R. Cheatham.

L. R. Cheatnam.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB86-164217
AS. Price codes: A08 in paper copy, A01 in microfiche. Mississippi Water Resources Research Institute, Mississippi Water Resources Completion
Report, September 1985, 146 p, 2 fig, 35 tab, 57 ref. USGS Project No. G915-02.

Descriptors: \*Groundwater management, \*Economic impact, \*Political aspects, \*Mississippi, Water policy, Water use, Water law, Water alloca-

This study was designed to provide an economic and institutional assessment of alternative strategies to deal with the type of groundwater mining problems encountered in Mississippi and determine how solutions can best be implemented and adminissolutions can be use the implementation and adminis-tered through a functional framework. Emphasis was placed on dealing with obstacles and con-straints which have historically prevented effective straints which have historically prevented effective management planning and implementation of solutions to problems. Experiences of other regions of the nation provide useful practices transferable to areas where irrigation and catfish farming are the primary causal factors. A case study investigation using the Tombigbee River Valley Water Management District (TRVWMD) and the encompassed Tupelo-Lee County area provided a mechanism for investigating localized overdraft problems due to population growth and industrial development. Findings from previous studies and three series of to population growth and industrial development. Findings from previous studies and three series of questionnaires provided data to evaluate options and economic impacts. The only permanent solution to localized overdraft is conjunctive supply systems. An organization like TRVWMD will likely not enter directly into the business of supplying water. However, it is likely to be an important link in the administrative framework of the state management system and play a major role in estab. management system and play a major role in establishment of groundwater control criteria. (Cheatham-MSU)

METHODOLOGY FOR A WATER MANAGE-MENT PLAN IN A WATER SURPLUS STATE, Mississippi State Univ., Mississippi State. Dept. of Civil Engineering. G. F. Mitchell, and D. A. Krane.

Available from the National Technical Information Service, Springfield, VA 22161, as PB86-164225/ Service, Springfield, VA 22161, as PB86-164227 AS. Price codes: AO7 in paper copy, AO1 in micro-fiche. Mississippi Water Resources Research Insti-tute, Mississippi State. Technical Completion Report, September 1985. 122 p, 99 fig. 3 tab, 75 ref, 4 append. USGS Project No. G915-03.

Descriptors: \*Water allocation, \*Management planning, \*Water use, Water management, Groundwater management, Water policy.

In a desire to promote industrial and agricultural growth, water surplus states have allowed indis-criminate and often wasteful appropriations of their seemingly abundant groundwater resources. However, it is now realized that rates of groundwater withdrawal are excessive and in some areas

have approached critical conditions. In order for have approached critical conditions. In order for water surplus states to continue to grow and expand economically, a balanced water management programs is essential. This research project begins the process of developing a water management methodology through evaluation of existing state water management plans and a survey of community water system managers in a water surplus state. Documents were obtained from 31 of the 50 states and evaluated by classifying them along several analytical dimensions such as centralization of state water management agencies. Several figures were prepared for comparison on the basis of the existing water legislation, type of management plan suggested and fragmentation of basis of the existing water legislation, type of man-agement plan suggested and fragmentation of water management authority. A 20% return was obtained of the survey of water system managers. Of this group over one-fourth perceived their local water supply to be adequate indefinitely. Twenty-seven percent did not measure water supplied, and 14% did not measure water used. Over half felt that management of groundwater in existing leg-14% out not measure water used. Over nar reit that management of groundwater in critical areas should be handled by apportioning among users with basis of apportionment either equally among users or secondly by priority use formula. (Mitch-

HYDROGEOLOGY IN THE VALUATION OF MINERAL DEPOSITS (CONCURSO DE LA HI-DROGEOLOGIS SUBTERRANEA EN LA VA-LORACION DE YACIMIENTOS),

Sociedad Minera y Metalurgica de Penarroya-Espana S.A.

Espana S.A.
P. Garcia-Caro.
IN: Water in Mining and Underground Works (El
Agua en la Mineria y Trabajos Subterraneos), Volumes I and II, 1984. SIAMOS 78. p 1225-1232.

Descriptors: \*Economic aspects, \*Cost-benefit analysis, \*Mineral industry, Cost analysis, Evaluation, Minerals, Parametric hydrology, Market

For the establishment of a plan concerning the investment in and exploitation of an ore deposit, it is necessary to know the parametric measure that, coupled with the market position, allows the calculation of the final expected profit. Certainty increases with greater knowledge of the ore deposit. In this stage of the evaluation, not considering the presence of underground water could cause the ruin of the project. (Author's abstract) W87-09900

#### 6C. Cost Allocation, Cost Sharing, Pricing/Repayment

STRATEGIES FOR CONVERSION OF HIGHLY ERODING CROPLAND IN WEST TENNESSEE,

Tennessee Univ., Knoxville. Dept. of Agricultural Economics and Rural Sociology. W. M. Park, L. H. Keller, R. J. Menard, and S. E.

Monteith.

Available from the National Technical Information Service, Springfield, VA 22161, as PB87-177143/
AS. Price codes: A04 in paper copy, A01 in microfiche. Tennessee Water Resources Research Center, Knoxvill. Research Report No. 112, September 1986. 43 p. 17 ref. Contract No. 14-08-0001-G1045-03. USGS Project No. G1045.

Descriptors: \*Cropland, \*Erosion control, \*Cost analysis, \*Tennessee, Cost sharing, Public policy, Education, Regulations.

High rates of erosion from marginal cropland in Mest Tennessee result in substantial off-site costs of sedimentation and water quality degradation. Traditional approaches involving technical and financial assistance in federal soil erosion control programs have not been very effective in inducing conversion of such cropland to permanent vegeta-tive cover. Partial explanations for this include the following: soybean price incentives encouraged acreage expansion in the 1970's; marginal, highly eroding land typically makes up a small portion of cropland fields; farm structure has shifted toward crop specialization without livestock enterprises:

Water Demand-Group 6D

farmers may not recognize the degree of erosion problem; farmers may overestimate yields and underestimate production costs. Use of the variable cost-share level option in the Agricultural Conservation Program does not appear to result in somewhat greater conversion of more highly eroding land, however, the cost-share formula could be modified to strengthen incentives toward this end. A differential bid approach offering annual payments for long-term conversion could target highly eroding land, but the public cost per ton of erosion reduction would be relatively high. Information and education strategies seem to have an important role to play, while regulatory approaches would face barriers of administrative and political feasibility. (Gangaware-Univ. of Tenn.) farmers may not recognize the degree of erosion

WATER AND THE MICHIGAN ECONOMY: ESTIMATING THE ECONOMIC VALUE OF MICHIGAN'S FRESH WATER, Michigan State Univ., East Lansing. Dept. of Agricultural Economics.
L. W. Libby, J. P. Hoehn, J. Caudill, and D.

Walker.

Available from the National Technical Information Available from the National 1 echnical Information Service, Springfield, VA 22161, as PB87-172672/ AS. Price codes: A07 in paper copy, A01 in micro-fiche. Michigan Water Research Institute, East Lansing, Michigan. Publication No. G1024-05, June 1986. 126, p. 12 fig. 9 tab, 82 ref, append. Contract No. 14-08-0001-G1024. USGS Project No. G1024-05

Descriptors: \*Water resources, \*Water management, \*Water value, \*Michigan, Planning, Modeling, Economics, Public water systems, Water

Michigan's water resources are an important input into a range of residential, agricultural, recreational, and commercial activities. Because these various activities draw upon the same water resources, conflicts arise. Resolution of these conflicts require tradeoffs and compromise. One way to quantify the tradeoffs involved in water quality managethe tradeoffs involved in water quality management is to measure the economic value of water resources to the various interests involved. The primary objective of this study was to contribute to the development of information and procedures for assessing the economic value of Michigan's water resources. Given the existing policy demands and the generic nature of economic valuation procedures, the study focused on the management readeoffs: ation procedures, the study focused on the man-agement tradeoffs involving groundwater re-sources. The study's main accomplishments in-clude a description of methods to: I. Improve the quality of information available for groundwater quanty of information available for groundwater planning and management in Michigan. 2. Develop and apply procedures for estimating the economic values associated with some subset of Michigan's groundwater resources. 3. Establish a basis for continuing research on the economic value of water resources. (USGS)

W87-09763

EVALUATION OF USER CHARGES TO FI-NANCE WATER SERVICES, Georgia Univ., Athens. Inst. of Natural Resources. R. M. North, H. A. Pless, J. Sellers, and Y.

Parmelee.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-179503/AS. Price codes: A04 in paper copy, A01 in microfiche. Environmental Resources Center, Georgia Institute of Technology, Atlanta, Report No. ERC 06-86, July 1986. 58 p. 11 tab, 9 fig. 10 ref. Contract No. 14-08-0001-G1011. USGS Project No. G1011-06.

Descriptors: \*Pricing, \*User charges, \*Cost sharing, \*Financial feasibility, Financing, Economic cost, Water rates, Repayment, Demand, Benefit cost analysis, Cost allocation, Water rights, Tariff, Market value, Water policy, Georgia.

As appropriated Federal funds for water resources As appropriate receival must for water resources projects, programs and services decline the funding needs must be made up by state and local governments and/or by the private sector businesses and consumers. As the responsibility for infra-

structure moves to the private sector it is essential for economic efficiency and financial feasibility to price water services at their full cost or at least a price that reflects their value to consumers and users in a manner that covers at least the full cost. price that reflects their value to consumers and users in a manner that covers at least the full cost. For all of the flow services produced by water (supply, waste treatment, hydropower), a two part tariff is recommended to reflect a capacity charge and a commodity charge. Tariffs should be set to reflect the high fixed cost of service and to reflect user willingness to pay for essential services. The excess revenue may be used to provide for welfare transfer to low income users or to provide for water related common goods type services such as flood control or environmental enhancement. This study reviews demand theory and presents a case study for Price/Income elasticities of demand for Georgia municipal systems to illustrate Price and Income effects on revenues. Similar theoretical constructs are presented for two market pricing solutions and for discriminatory pricing within a market for flow type commodities, both systems intended to generate revenue more closely aligned intended to generate revenue more closely aligned to market value of the services provided. A second case study is used to show how updated 'alterna-tive cost' pricing will lead to increases of 4-10 times in the revenue received from hydropower generation (capacity and energy). Although some repayments are long term contracts, there are op-portunities to renegotiate contracts for better terms to Federal agencies producing and marketing hy-dropower. Specific details are given for the South-east Power Administration. (SEPA) (North-Univ. of Georgia) W87-09780

ORGANIZATION, CAPITAL NEEDS AND FINANCIAL CAPACITY OF FMHA-FINANCED WATER SUPPLY UTILITY SYSTEMS IN SOUTH CAROLINA, Clemson Univ., SC. Dept. of Agricultural Economics and Rural Sociology.
J. C. Hite, B. L. Dillman, G. L. Carriker, and G. B. Timubu.

Available from the National Technical Information Service, Springfield, VA 22161, as PB86-157088/ AS. Price codes: A04 in paper copy, A01 in micro-fiche. South Carolina Water Resources Research Institute, Clemson. Report No. 118, August 1985. 47 p, 18 tab, 2 ref. Contract No. 14-08-0001-G932. USGS Project No. G932-02-SC.

Descriptors: \*Pricing, \*Repayment, \*Water demand, \*Evaluation process, \*Economic projections, \*South Carolina, Cost allocation, Cost sharing. Data acquisition.

ing, Data acquisition.

An overview is presented of the organization and financial condition of the 344 community water systems in South Carolina operated by governmental or quasi-governmental non-profit water companies or authorities. Hypotheses are presented from a preliminary analysis of data provided by two state government agencies and a survey of Farmers Home Administration (FmHA) borrowers. Preliminary analysis allows little generalization about the financial characteristics of water supply systems due to large ranges and high standard errors on the different income statement and balance sheet items. Looking at individual systems, however, it is clear that there are some with present or potential financial difficulties; e.g., some systems have operating expenses exceeding operating income, and some have negative debt/equity ratios. While there are not obvious economies of scale associated with capacity. It appears that, if periodic water shortages are to be avoided, treatment capacity will need to be expanded by 12 to 30 percent of the systems, the upper figure probably being more realistic. Ways and means must be found to finance this expansion of treatment capacity as federal loan and grant programs are terminated. (Dillman-WRRI) W87-09786

TEXAS STREAM-GAGING PROGRAM: AN ANALYSIS OF DATA USES AND FUNDING, Geological Survey, Austin, TX. Water Resources For primary bibliographic entry see Field 7A.

W87-09835

HYDROGEOLOGY IN THE VALUATION OF MINERAL DEPOSITS (CONCURSO DE LA HI-DROGEOLOGIS SUBTERRANEA EN LA VA-LORACION DE YACIMIENTOS), Sociedad Minera y Metalurgica de Penarroya-For primary bibliographic entry see Field 6B. W87-09900

#### 6D. Water Demand

ORGANIZATION, CAPITAL NEEDS AND FINANCIAL CAPACITY OF FMHA-FINANCED WATER SUPPLY UTILITY SYSTEMS IN SOUTH CAROLINA, Clemson Univ., SC. Dept. of Agricultural Economics and Rural Sociology.

For primary bibliographic entry see Field 6C. W87-09786

MODELING IRRIGATION IN THE COLUM-BIA, Washington State Univ., Pullman. Coll. of Agri-For primary bibliographic entry see Field 3F. W87-09793

METHODOLOGY FOR A WATER MANAGE-MENT PLAN IN A WATER SURPLUS STATE, Mississippi State Univ., Mississippi State. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6B.
W87-09803

DESCRIPTION OF WATER-SYSTEMS OPERATIONS IN THE ARKANSAS RIVER BASIN, COLORADO, Geological Survey, Pueblo, CO. Water Resources

For primary bibliographic entry see Field 5F. W87-09852

PLANNING FOR THE FUTURE. FURILY FURIER FUTURE, Pirnie (Malcolm), Inc., White Plains, NY. G. P. Westerhoff, and J. Berkum. Water Engineering and Management WENMD2, Vol. 134, No. 2, p 20-23, February 1987.

Descriptors: \*Water management, \*Water demand, \*Water quality management, Water supply devel-opment, Water resources development, Water supply, Population dynamics, Land use, Water conservation, Water reuse, Water quality, Water distribution, Economic aspects, Political aspects.

As a result of shifting water management responsi-bilities, communities across the USA are becoming more conscious of the need to reinforce supply and demand strategies. Potentially available water sources often cannot meet the demands of those sources often cannot meet the demands of those competing for them, especially in areas with rapid-pexpanding populations. Future water need must be based on population and land use projections, as well as on evaluations of existing surface or groundwater systems. Conservation and reuse must play an increasingly more important role in augmenting available supplies. Water quality concerns and the contamination potential are significant factors in the choice of supplies, dictate treatment strategies, and influence the selection of raw water sources. Eight of the critical areas which must be considered in water resources planning were discussed in detail with examples given; they include demographics, quality, supply, distribution, environmental, institutional and financial factors, and public relations. It was shown that water supply planning and management can no longer be supply planning and management can no longer be treated as separate issues, and that water quantity issues cannot be separated from water quality issues. It was concluded that planning, quantity, and quality issues must be integrated into a comprehensive water resources management pla which encompasses as large an area as is politically feasible. (Wood-PTT)

#### Field 6-WATER RESOURCES PLANNING

#### Group 6D-Water Demand

W87-09935

#### 6E. Water Law and Institutions

MAINTAINING SCIENTIFIC INTEGRITY UNDER PRESSURE: THE EXPERIENCE OF THE SOUTHERN CALIFORNIA WATER RESEARCH AUTHORITY, For primary bibliographic entry see Field 5E. W87-09635

ENVIRONMENTAL LAWS AND ENVIRON-MENTAL IMPROVEMENT.

Quad Consultants, Visalia, CA. W. F. Garber.

Water Science and Technology WSTED4, Vol. 18, No. 11, p 205-218, 1986. 5 fig. 1 tab. 13 ref.

Descriptors: \*Legislation, \*Legal aspects, \*Wastewater disposal, \*Outfall, \*Waste disposal, \*Wastewater, Coastal waters, Effluents, Environ-

The Congress of the United States, in responding to the environmental concerns of the citizens, enacted a complex of legislation covering the impacts of wastes upon the land, air and water. In addition to Federal laws and regulations, each state may also have separate regulations which apply and asso have separate regulations which apply and which may be more severe or restrictive than the national requirements. In developing such legisla-tion the people in the states distant from Washing-ton DC, believed Congress also had to consider the problems inherent in allowing case by case considerations with lack of uniformity, and the considerations with lack of uniformity, and the administrative and legal problems inherent in allowing flexible regulations. Additionally, the possible problem of industry shifts to areas more favorable for waste discharges had to be considered. NACOA in its January 1981 report pointed out that as a result, each law was single disposal medium oriented, and that there was no real provision for as internancial emissione result evaluation. sion for an inter-media environmental evaluation to try to seek the most responsible environmental method or media of disposal. (Alexander-PTT) W87-09652

DRINKING-WATER AND WOMEN CAN DO MUCH. SANITATION:

International Reference Centre for Community Water Supply and Sanitation, The Hague (Nether-

For primary bibliographic entry see Field 5F. W87-09682

GAPS, CONFLICTS, OVERLAPS, AND INCON-SISTENCIES IN TENNESSEE'S ENVIRON-MENTAL LAWS AND REGULATIONS, Vanderbilt Univ., Nashville, TN. Dept. of Civil and Environmental Engineering.
L. Thackston, and G. A. Davis.

Available from the National Technical Information Available from the National 1 ectinical information Service, Springfield, VA 22161, as PB86-167665/ AS. Price codes: A07 in paper copy, A01 in micro-fiche. Tennessee Water Resources Research Center Technical Completion Report 110, Septem-ber 1985. 123 p. 20 ref, 2 append. Contract No. 14-08-0001-G934. USGS Project No. G-934.

Descriptors: \*Environmental laws, \*Regulations, \*Legislation, \*Tennessee, Hazardous wastes, Solid wastes, Water quality, Air pollution, Political aspects, Groundwater, Public policy, Water law

Tennessee's environmental protection laws and regulations were studied and discussed with representatives of three major interest groups - the regulators (primarily in the Department of Health and Environment), the regulated community, and conservation groups and natural resource manage-ment agencies. Most of the 34 problems discussed in the report involve statutory gaps in Tennessee's laws or overlaps of federal hazardous waste laws and regulations with the three media-oriented reg-ulatory programs (air, water, and solid waste). A few outright conflicts were discovered, probably the most serious of which involves discharge of

pollutants from landfills to groundwater. The most serious gaps were either in hazardous waste regula-tions (which reflect federal regulations), or in extions (which reflect federal regulations), or in ex-emptions in the Water Quality Act for non-point sources of pollutants, agricultural activities, and forestry activities. There is no wetlands protection program. The most unjustified gap, and potentially the most dangerous, allows blasting of bedrock to allow septic tank effluent to be discharged, unfil-tered, directly to the groundwater. (USGS) W87-09746

FUTURE DRINKING WATER - STATE AND LOCAL POLICIES FOR PROTECTING FUTURE DRINKING WATER RESERVOIR SITES AND WATERSHEDS IN NORTH CARO-

North Carolina Univ. at Chapel Hill. Center for Urban and Regional Studies.
For primary bibliographic entry see Field 5G.

SYSTEM COOPERATION IN REGIONAL WATER SUPPLY PLANNING, Washington Univ., Seattle. Dept. of Civil Engi-

neering.
J. R. Lund, and R. N. Palmer.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB86-157401.
AS. Price codes: AO7 in paper copy, AO1 in microfiche. Water Resources Series Technical Report
No. 95, June 1985. 122 p, 11 fig, 17 tab, 83 ref.
Contract No. 14-08-0001-G940. USGS Project No.
G940-08 (A-132-WASH).

Descriptors: \*Water supply, \*Water supply development, \*Washington, \*Governmental interrelations, Water conveyance, Regional planning, Rural

The problems of small water systems have achieved increasing prominence in recent years with recognition of their particular cost, water quality, reliability, and fire protection problems. One suggested approach to address these problems is cooperation among water systems. This report studies this approach, reviewing proposed cooperative measures, suggesting some optimization techniques, and discussing the data and institutional problems involved in planning regional cooperaproteins involved in planning regional coolera-tion among small water supplies. The role of system cooperation in regional water supply devel-opment is also addressed. (Palmer-U of Wash) W87-09798

ECONOMIC IMPACTS OF ALTERNATIVE RESOLUTIONS OF NEW MEXICO PUEBLO INDIAN WATER RIGHTS; VOLUME 1: PUEBLO INDIAN WATER RIGHTS, VORTEX IN THE STRUGGLE FOR A PRECIOUS RE-

New Mexico Univ., Albuquerque. School of Law. A. Utton, and C. DuMars. Available from the National Technical Information Available from the National 1 echnical information Service, Springfield, VA 22161, as PB86-151495/ AS. Price codes: A13 in paper copy, A01 in micro-fiche. New Mexico Water Resources Research In-stitute, Las Cruces. Completion Report, January 1983. 300 p, 6 tab, 9 append. Project No. B-064-NMEX.

Descriptors: \*Water law, \*Water rights, \*Indian water rights, \*New Mexico, Pueblo Indians, Indi-ans, Appropriation, Legal aspects, Treaties, Win-ters decision, Judicial decisions, Pueblo Lands Act,

The legal theories applicable to the water rights of the New Mexico Pueblo Indians are explored. The aboriginal water rights theory gives the Pueblo Indians a paramount water-right priority in time. However, the quantity of water remains debatable under historic use or expanding right doctrine. The treaty right theory is based on Spanish and Mexican law in force when the Pueblos were Mexicans at the time of the Treaty of Guadalupe-Hidalgo. This provides the Indians a priority based on the principles of prior appropriation with quantities depending on an expanding need principle which considers the rights of third parties and community

equity. According to the Winters decisions the Indian water right would be determined by the date of reservation, and the quantity would be determined by the principle of practicably irrigable acres. The Pueblo Lands Acts of 1924 and 1933 have produced disagreements. The state of New Mexico argues that Indian water rights are limited by water rights appurtenant to non-Indian lands. The Indians claim that this law can be interpreted as giving them an aboriginal water right with a practicably irrigable acreage standard for quantifying the rights. The historical background of this nonresolution are discussed. A solution, based on nonresolution are discussed. A solution, based on existing state water laws, is proposed. Under this scheme existing water rights can be purchased by the federal government and given to the Pueblo Indians in accordance with their expanding needs. (Cassar-PTT) W87-09799

ECONOMIC IMPACT OF ALTERNATIVE RES-OLUTIONS OF NEW MEXICO PUEBLO INDIAN WATER RIGHTS; VOLUME III: THE ECONOMIC IMPACT OF ALTERNATIVE RES-OLUTIONS OF PUEBLO INDIAN WATER RIGHTS IN THE UPPER RIO GRANDE

RIGHTS IN THE UPPER RIO GRANDE BASIN, New Mexico Univ., Albuquerque. Bureau of Business and Economic Research.

J. C. Tysseling, and B. McDonald.

Available from the National Technical Information Service, Springfield, VA 22161, as PB86-151503/AS. Price codes: A16 in paper copy, A01 in microfiche. New Mexico Water Resources Research Institute, Las Cruces. Completion Report, July 1983. 350 p. 29 fig., 39 tab, 3 maps. USGS Project No. B-064-NMEX.

Descriptors: \*Water law, \*Water rights, \*Indian water rights, New Mexico, Pueblo Índians, Indians, Legal aspects, Model studies, Economic impact, Social impact, Rio Grande Basin, Water supply, Water demand, Agriculture, Pueblo Land Acts, Winters decision, Leases.

The specific economic consequences of the possi-ble legal outcomes of Pueblo Indian water rights is ble legal outcomes of Pueblo Indian water rights is discussed. A model describes the impacts, which are the social and economic opportunities precluded or encouraged by specific alternative quantifications of Pueblo Indian water rights. The baseline solution (before change in Pueblo Indian water rights over 1975 levels) describes output in the 24 sectors of each Upper Basin region and concludes that no absolute water scarcity condition will exist the University of the Change Pueblo Region and concludes that no absolute water scarcity condition will exist the University of the Change Pueblo Region and concludes that no absolute water scarcity condition will exist the University of the Change Pueblo Region Pu sectors of each Upper Basin region and concludes that no absolute water scarcity condition will exist in the Upper Rio Grande Region which would constrain this economic development projection. An alternative scenario includes increased Indian agriculture with increases in output and water scarcity. Another alternative scenario describes the leasing of water by the Indians. Impacts would depend on the lease price charged. In general, the model shows changes in the geographic distribution and use of available water resources in the Upper Rio Grande Basin. On the whole, the economic impacts associated with the specific quantification of Indian water rights appear at worst neutral, with the potential for positive net economic benefits in the Upper Basin associated with specific resolution scenarios. These economic impacts are described as changes in output and water utilization by Upper Basin society (Indian and non-Indian). Cultural impacts are not assessed. The general conclusion is that no economic reason exists to resist or delay the resolution of Pueblo Indian water right claims in the Upper Rio Grande basin. (Cassar-PTT)

ECONOMIC IMPACT OF WATER MANAGEMENT STRATEGY FOR WATER SURPLUS AREAS WITH GROUND WATER OVERDRAFT PROBLEMS,

RNUBLEMB, Mississippi State Univ., Mississippi State. Div. of Business Research. For primary bibliographic entry see Field 6B. W87-09802

METHODOLOGY FOR A WATER MANAGEMENT PLAN IN A WATER SURPLUS STATE,

#### Network Design-Group 7A

Mississippi State Univ., Mississippi State. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6B.
W87-09803

#### 6G. Ecologic Impact Of Water Development

CACHE AND QUARRY: ARCHAEOLOGICAL DEPOSITS IN THE TRIGO MOUNTAINS, YUMA COUNTY, ARIZONA, HART MINE QUARRY NO. 1 (CIBOLA) AND NO. 2 EXPAN-

Mooney-LeVine and Associates, San Diego, CA. J. Schaefer, and C. M. Elling. Available from the National Technical Information

Available from the National Lectinical information Service, Springfield, Virginia 22161, as PB87-173332, A05 in paper copy, A01 in microfiche. Prepared for Bureau of Reclamation, Boulder City, NV, Lower Colorado Region. March 17, 1987. 85 p, 10 fig, 1 tab, 84 ref.

Descriptors: \*Archaeology, \*Yuma, \*Arizona, \*Colorado River, Trigo mountains, History, Water resources development

This report provides a brief discussion of the Hart Mine Quarry expansion, followed by a review of the lower Colorado River cultural history. Emphasis is given to Patayan occupation and ethnohistoric Halchidhoma and Mojave patterns to which several caches and temporary camps are attributed. Section III presents a description of field methods and results, followed with a description of each site, organized by site type. Section IV includes an assessment of scientific significance as a basis for determination of National Register eligibility. The significance of each site is documented and discussed within the context of hunter-gatherers or cussed within the context of hunter-gatherers or late prehistoric horticultural exploitation of upland terraces and mountains bordering the Colorado River floodplain. Impact projections are made for each site and mitigation recommendations are provided. Section V reiterates significance of cultural resources. Class III intensive cultural resources inventory of 1,120 acres for proposed expansion of Hart Mine Quarry No. 1 (Cibola) and Hart Mine Quarry No. 2. A total of 23 sites and 2 isolates were discovered on the western flank of the Trigo Mountains, six to seven miles east of the Colorado River in West Central Yuma County, Arizona. (Lantz-PTT) late prehistoric horticultural exploitation of upland (Lantz-PTT) W87-09687

PREHISTORIC ACTIVITIES AND HISTORIC MINING IN THE RIVERSIDE MOUNTAINS: A

MINING IN THE RIVERSIDE MOUNTAINS: A CULTURAL RESOURCE INVENTORY FOR THE AGNES-WILSON RIP-RAP QUARRY EXPANSION PROJECT, RIVERSIDE COUNTY, CALIFORNIA, Mooney-LeVine and Associates, San Diego, CA. C. M. Elling, and J. Schaefer. Available from the National Technical Information Service, Springfield, Virginia 22161, as PB87-178984, A04 in paper copy, A01 in microfiche. Prepared for Bureau of Reclamation, Boulder City, NV, Lower Colorado Region. March 20, 1987. 68 p, 14 fig, 1 tab, 59 ref.

Descriptors: \*Archaeology, \*California, \*Colorado River, \*Riverside County, \*Riprap, History, Water resources development, Mitigation, Coal

On January 5-9, 1987, an intensive, Class III archaeological survey was carried out within the 720-acre parcel for the proposed Agnes-Wilson Quarry expansion project for the Bureau of Reclamation. Record searches and pre-field research indicated that no sites had been previously recorded but that the area had high potential for historic mining resources. The results of the surveys were consistent with the prediction that there were likely to be cultural resources from various phases of ore extraction in the Riverside Mountains. Addiof ore extraction in the Riverside Mountains. Addi-tionally, five locations of prehistoric activities were discovered and documented. The prehistoric sites discovered indicate a short-term use of the area. No intensively occupied base camps or sea-sonally inhabited temporary camps with midden

deposits, features, high artifact inventories, or highly diverse assemblages were found. The two historic mining complexes, however, indicate an historic mining complexes, however, indicate an extended occupation in and exploitation of the immediate area; a use of the area for nearly 100 years since gold was first discovered here in 1898. Various occupations and operations occurred here through time by at least four different companies and individuals. The names of the claims changed often, making for a rather difficult, although not impossible, task to trace the history of the mine. The artifacts, mining foundations, and associated features are in a fairly well preserved condition; however, later mining operations did impact those from earlier times. Nevertheless, due to the availability of records, the integrity of the mining resources, and the possibility that individuals who once worked at the mines may still be alive, the potential for writing a local history of mining operations in one location over a period of one hundred years is great. (Lantz-PTT)

CLASS II CULTURAL RESOURCES SURVEY FOR THE GILA LAND DISPOSAL PROJECT, YUMA COUNTY, ARIZONA, Statistical Research, Tucson, AZ. J. H. Altschul, and S. D. Shelley. Available from the National Technical Information Service, Springfield, Virginia 22161. Prepared for Bureau of Reclamation, Boulder City, NV, Lower Colorado Region. Technical Series, No. 8, 1987. 38 p, 10 fig, 2 tab, 47 ref.

Descriptors: \*Archaeology, \*Gila Land Disposal Project, \*Yuma, \*Arizona, \*Colorado River, His-tory, Statistical analysis, Model studies, Water resources development

During January of 1987, a Class II cultural resources survey was conducted for the Bureau of Reclamation, Lower Colorado Region, of approximately 5330 acres composed of 14 discrete parcels near the towns of Wellton and Tacna, Arizona. near the towns of wellton and lacina, Arizona. Approximately 25.2% of the project area was surveyed using a combination of judgemental and random transects. The judgemental sample concentrated on areas thought to have the highest probability of containing sites. A 15% random sample was conducted in order to make parameter estimated the control of the property of the property of the control of the property of the project of was conducted in order to make parameter esti-mates of site density and locations. The research design on which the project was based was derived from a regional research design and settlement model devised by Doelle. The results of the survey model devised by Doelle. The results of the survey proved largely negative. A total of three isolated prehistoric Patayan shards and isolated possible flake were recovered. The lack of archaeological sites in the project area appears to be due to a lack of permanent, or temporary, but dependable water sources. Based on these findings no further work was recommended for the project area. (Author's bstract)

RIVER-QUALITY ASSESSMENT OF THE TRUCKEE AND CARSON RIVER SYSTEM, CALIFORNIA AND NEVADA -- HYDROLOGIC CHARACTERISTICS, Geological Survey, Sacramento, CA. Water Re-

e Div

W. M. Brown, J. O. Nowlin, L. H. Smith, and M. O. Regan. Available from USGS, OFSS, Box 25425, Denver,

CO 80225. USGS Open File Report 84-576, 1986. 201 p. 23 fig. 6 tab. 25 ref. 3 plates.

Descriptors: \*Hydrology systems, \*Water quality, \*River quality assessments, \*California, \*Nevada, \*Truckee River, \*Carson River, Resources man-agement, Aerial photography, Maps.

A study of the Truckee and Carson Rivers was begun in October 1978 to assess the cause and effect relations between human and natural actions, and the quality of water at different times and places along the rivers. This report deals with the compilation of basic hydrologic data and the presentation of some of the new data collected during the study. Topographic, flow, and chemical data, data from recent time-of-travel studies, and new data on river mileages and drainage areas that were

determined using new, high-resolution maps, are included. The report is a guide to locating maps, aerial photographs, computer files, and reports that relate to the rivers and their basins. It describes methods for compiling and expressing hydrologic information for ease of reading and understanding by the many users of water-related data. Text, tabular data, and colored plates with detailed maps and hydrographs are extensively cross reference (USGS) W87-09816

DESCRIPTION OF SEDIMENT DATA COL-LECTED BY THE U.S. GEOLOGICAL SURVEY IN SMALL WATERSHEDS IN COAL-MINING AREAS OF THE EASTERN UNITED STATES, 1980-84,

For primary bibliographic entry see Field 2J. W87-09822

EFFECTS OF INCREASED PUMPAGE ON A FRACTURED-BEDROCK AQUIFER SYSTEM IN CENTRAL ORANGE COUNTY, NEW YORK, Geological Survey, Albany, NY. Water Resources

For primary bibliographic entry see Field 2F. W87-09861

RELATIONSHIP OF AQUATIC ECOREGIONS, RIVER BASINS AND PHYSIOGRAPHIC PROVINCES TO THE ICHTHYOGEOGRA-PHIC REGIONS OF OREGON, Northrop Services, Inc., Corvallis, OR. For primary bibliographic entry see Field 2H. W87-09939

#### 7. RESOURCES DATA

#### 7A. Network Design

DESIGN FOR RESERVOIR

WATER QUALITY INVESTIGATIONS, Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.

R. F. Gaugush.

Available from the National Technical Information Service, Springfield, Virginia 22161. Instruction Report E-87-1, March 1987. Final Report. 86 p, 16 fig, 14 tab, 15 ref, append.

Descriptors: \*Monitoring, \*Data collections, \*Sampling, \*Water sampling, \*Reservoirs, \*Water quality, Statistical methods, Design standards, Sta-tistical studies, Distribution patterns.

The statistical concepts involved in the development of sampling designs for reservoir water quality investigations are discussed with a general overview of statistical inference and the assumptions involved in sampling. Methods of sampling design are presented with specific reference to reservoir water quality sampling and covers the determination of sample size, simple random sampling, stratified random sampling, and systematic sampling. The report also presents the use of decision matrices, tools to aid in the decision making process involved in determining the number of samples, the parameters to be measured, and the frequency of sampling within funding constraints. Reservoir water quality patterns and their implications for sampling design are discussed with an emphasis on the influence of parameter frequency distributions, spatial patterns, and temporal patterns on sampling design. From the consideration emphasis on the influence of parameter requestive distributions, spatial patterns, and temporal patterns on sampling design. From the consideration of reservoir water quality patterns, a generalized reservoir sampling design is developed. Methods for the evaluation of an implemented sampling design are also considered. The techniques of variations of the consideration of the considera ance component analysis, cluster analysis, and error analysis can be used to determine the effec-tiveness of a given sampling design. (Lantz-PTT) W87-09632

DESIGN OF A STATEWIDE GROUND WATER MONITORING NETWORK, Tennessee Technological Univ., Cookeville. Center for the Management, Utilization and Pro-

#### Field 7—RESOURCES DATA

#### Group 7A-Network Design

tection of Water Resources.
T. M. Wilson, V. D. Adams, R. T. Brown, J. A. Gordon, and H. H. Mills.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-177283/
AS. Price codes: A10 in paper copy, A01 in microfiche. Tennessee Water Resources Research Center Knoxvill. Research Report No. 113, Sep-tember 1986. 199 p, 37 fig, 21 tab, 69 ref. Contract No. 14-08-0001-G1045. USGS Project No. G1045-

Descriptors: \*Groundwater, \*Monitoring design, \*Aquifers, \*Tennessee, Physiographic provinces, Wells, Data base, Water quality, Geochemistry.

Designing a groundwater monitoring network for the state of Tennessee is a difficult assignment because of the great number of factors that must be because of the great number of factors that must be blended together to create an effective monitoring plan, and the diverse nature of the geohydrologic settings within Tennessee. The major physiographic provinces define to some extent the spatial context for the groundwater development, use, susceptibility to potential contamination, and necessary monitoring efforts. In other regards, the broad perspective of these general regions of geologic features is far too large for meaningful analysis. Local characteristics of the water bearing fornation must also be considered. Although many ss. Local characteristics of the water bearing for-mation must also be considered. Although many previous papers have attempted to characterize water quality of particular areas or aquifers, no effort has been made to compare and contrast water quality of all regions and all major aquifers of the state in a quantitative fashion. Yet, for any of the state in a quantitative fashion. Yet, for any monitoring network design, it is vital to know how well ambient groundwater quality can be predicted across the state. For this reason, a statistical study of water quality data from Tennessee water wells was undertaken. The application of discriminant analysis to distinguish geological units on the basis of their composite water quality seems to be the most useful. It should be possible to partially define a typical water chemistry profile for each aquifer. most useful. If should be possible to partially define a typical water chemistry profile for each aquifer, allowing subsequent monitoring to look for deviations from this profile. For most of the aquifers and geological units, however, more data are needed before such profiles can be defined with a substantial degree of confidence. It is suggested that approximately 200 representative wells be sampled and analyzed quarterly over the next two years to obtain the required data. (USGS) W87-09747

REMOTE CONTROL OF HYDROMETEORO-LOGICAL DEVICES, Utah Center for Water Resources Research,

Logan. For primary bibliographic entry see Field 7B. W87-09766

INDEX OF SURFACE-WATER STATIONS IN

TEXAS, JANUARY 1986, Geological Survey, Austin, TX. Water Resources

For primary bibliographic entry see Field 7B. W87-09817

TEXAS STREAM-GAGING PROGRAM: AN ANALYSIS OF DATA USES AND FUNDING, Geological Survey, Austin, TX. Water Resources Div. B. C. Massey.

Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 85-084, 1985. 40 p, 1 fig, 2 tab, 6 ref.

Descriptors: \*Texas, \*Hydrologic data, \*Cost analysis, \*Stream gaging, \*Funding, Streamflow, Water quality, Basin characteristics, Hydrologic

This report presents an analysis of data uses and funding for the stream-gaging program operated by the U.S. Geological Survey in Texas. Presently (1984), 391 continuous surface water stations are operated in Texas. Selected hydrologic data, data uses, and funding sources are presented for each of the 391 stations. This study is a part of a larger project to determine the cost-effectiveness of the

stream gaging program in Texas. All stations have sufficient uses to justify their continued operation. (USGS)

PLAN OF STUDY FOR THE REGIONAL AQ-UIFER-SYSTEM ANALYSIS OF THE COLUM-BIA PLATEAU, WASHINGTON, NORTHERN OREGON, AND NORTHWESTERN IDAHO, Geological Survey, Tacoma, WA. Water Re-sources Div. For primary bibliographic entry see Field 2F. W87-09865

PUTTING THE GROUNDWATER MONITOR-ING PIECES TOGETHER, Pirnie (Malcolm), Inc., White Plains, NY. For primary bibliographic entry see Field 5G. W87-09936

#### 7B. Data Acquisition

RECENT ASPECTS OF STUDY METHODS OF DRAINAGE OF OPEN PITS EXCAVATIONS
(ASPECTS RECENTS DES METHODES
D'ETUDE DU DRAINAGE DES MINES A CIEL Bureau de Recherches Geologiques et Minieres,

Orleans (France).
For primary bibliographic entry see Field 6A.
W87-09605

HYDROLOGICAL FORECASTING:

AND OPERATION OF HYDROLOGICAL FORECASTING SYSTEMS.

World Meteorological Organization, Geneva (Switzerland). Dept. of Hydrology and Water Resources.

D. Reidel Publishing Co., Dordrecht, Holland. 1986. 239 p.

Descriptors: \*River forecasting, \*Runoff forecasting, \*Streamflow forecasting, \*Forecasting, \*Weather forecasting, Flood forecasting, Predictions, Resources management, Model studies, Cost-benefit analysis, Evaluation.

Hydrological forecasts can be classified mainly by three, mutually interdependent characteristics: (a) The forecast variable; (b) The purpose of the fore-cast; and (c) The lead time, also known as forecast-ing or forewarning period. One of the most impor-tant criteria of the classification is the lead time. Its tant criteria of the classification is the lead time. Its definition is not universally accepted, but a large consensus can be assumed around the following one: the lead time is the time between the issuance of the forecast of a hydrological phenomenon and its occurrence. This lead time may be considered as the net lead time, a gross lead time would be the time between the occurrence of the cause(s) of a hydrological phenomenon and its occurrence (i.e. hydrological phenomenon and its occurrence (i.e. between the occurrence of a rain causing a flood and the flood peak occurrence). Components of hydrological forecasting systems, selection of forecasting procedures, forecast updating and evaluation, benefit and cost analysis of hydrological forecasts, and examples of design of hydrological forecasting are the chapter topics discussed in this book. (Lantz-PTT) W87-09630

SAMPLING DESIGN FOR RESERVOIR WATER QUALITY INVESTIGATIONS, Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab. For primary bibliographic entry see Field 7A. W87-09632

POTENTIAL FOR SOLUTE RETARDATION ON MONITORING WELL SAND PACKS AND ITS EFFECT ON PURGING REQUIREMENTS FOR GROUND WATER SAMPLING, Oregon Graduate Center, Beaverton. Dept. of Environmental Science and Engineering. C. D. Palmer, J. F. Keely, and W. Fish.

Ground Water Monitoring Review GWMRDU, Vol. 7, No. 2, p 40-47, Spring 1987. 5 fig, 30 ref. USGS Grant 14-08-0001-A0410.

Descriptors: \*Monitoring wells, \*Groundwater pollution, \*Groundwater movement, \*Path of pollutants, \*Retardation, Solutes, Groundwater, Aquifers, Organic compounds, Metals, Ions.

Monitoring well sand packs are theoretically capable of retarding metal ions and organic contaminants. If this retardation does indeed occur it may have a significant effect on the purging requirements of newly installed monitoring wells. Calculations based on mass balance and retardation concepts demonstrate that if common guidelines for well purging are followed, contaminants may not be detected or many be detected in lower concentrations than are actually present in the groundwater. This problem is greatest in relatively shallow wells installed in low to moderate permeability materials. In most cases, the effect of solute retardation in the sand pack can be avoided simply by additional purging prior to the first sampling of the monitoring well. Common purging guidelines can then be applied to subsequent samplings. The methodology outlined can be used to calculate the purging requirements of existing monitoring wells or it may be applied to subsequent samplings. methodology outlined can be used to calculate the purging requirements of existing monitoring wells or it may be applied to alternative monitoring well designs to test which will require the smallest volume of purged water. (Author's abstract) W87-09667

SOME BIASES IN SAMPLING MULTILEVEL PIEZOMETERS FOR VOLATILE ORGANICS, Waterloo Univ. (Ontario). Dept. of Earth Sciences. J. F. Barker, G. C. Patrick, L. Lemon, and G. M.

Ground Water Monitoring Review GWMRDU, Vol, 7, No. 2, p 48-54, Spring 1987. 7 fig, 27 ref.

Descriptors: \*Piezometers, \*Groundwater pollution, \*Design criteria, \*Measuring instruments, \*Organic compounds, Field tests, Monitoring.

Multilevel piezometers are cost-effective monitoring devices for determining the three-dimensional distribution of solutes in groundwater. Construction includes flexible tubing (plastic or Teflon (R)). Their sampling is subject to a number of potential biases, particularly: (1) losses of volatile organic solutes via volatilization, (2) sorption onto the flexible tubing of the piezometers, (3) leaching of organics from this tubing, and (4) collection of unrepresentative samples due to inadequate piezometer flushing. It is shown that these biases are minimal or are easily controlled in most situations. Another source of bias has been recognized. Organic solutes present in groundwater above the screened level can penetrate the flexible plastic or Teflon tubing and contaminate the sampled water being drawn through this tubing. Laboratory tests and field results indicate this transmission causes low organic contaminant concentrations to be erroneously attributed to groundwater which is free low organic contaminant concentrations to be erroneously attributed to groundwater which is free of such contaminants. The transmitted organics apparently desorb from the plastic tubing during flushing of even 40 piezometer volumes. Recognition of this transmission problem provides for a better intersectation of pricting expansions. better interpretation of existing organic contami-nant distribution data. Caution is advised when considering the use of these monitoring devices in organic solute contaminant studies. (Author's abstract) W87-09668

EFFECTS OF SELECTED SAMPLING EQUIP-MENT AND PROCEDURES ON THE CON-CENTRATIONS OF TRICHLOROETHYLENE AND RELATED COMPOUNDS IN GROUND WATER SAMPLES, Geological Survey, Syosset, NY. Water Resources

Div.
K. A. Pearsall, and D. A. V. Eckhardt.
Ground Water Monitoring Review GWMRDU,
Vol, 7, No. 2, p 64-73, Spring 1987. 3 fig, 6 tab, 11

Descriptors: \*Measuring instruments, \*Sampling devices, \*Analytical methods, \*Comparison studies, \*Trichloroethylene, \*Groundwater pollution, Pumps, Bailers, Performance evaluation

#### Data Acquisition-Group 7B

Variations in concentrations of trichloroethylene and related compounds in groundwater obtained from seven groundwater samplers were used to compare the performance of three submersible pumps, a centrifugal pump, two peristaltic pumps, and a bailer. Two- and 4-inch diameter submersible pumps, a centrifugal pump, two peristaltic pumps, and a bailer. Two- and 4-inch diameter submersible pumps and a centrifugal pump produced samples whose trichloroethylene concentrations, on the average, did not differ significantly from each other. Groundwater samples collected by using a peristaltic pump and silicone tubing had significantly lower trichloroethylene concentrations than samples from the submersible pumps. Concentrations of 1,2-dichloroethylene and trichloroethylene in groundwater samples collected by using a bailer were indistinguishable from those in samples taken by a submersible pump when the concentrations were as much as 96 and 76 micrograms per liter, respectively, but were 15 and 12 percent lower when concentrations were as low as 29 and 23 micrograms per liter, respectively. Tests of different configurations of sampler placement in observation wells indicate that pump placement, rate of pumping, duration of pumping, and the uniformity of the vertical and lateral distribution of trichloroethylene in groundwater mear the well screen have a potentially significant influence on trichloroethylene in groundwater mear the well screen have a potentially significant influence on trichloroethylene concentrations in groundwater samples and that these factors can have a greater effect than the type of sampler used. (Author's abstract) W87-09671

SAMPLING THE CHEMISTRY OF SHALLOW AQUIFER SYSTEMS - A CASE STUDY, Agricultural Research Service, University Park, PA. Northeast Watershed Research Center. For primary bibliographic entry see Field 2F. W87-09673

CLOUD TYPE CLASSIFICATION WITH NOAA 7 SPLIT-WINDOW MEASUREMENTS, Meteorological Research Inst., Yatabe (Japan) T. Inoue

Journal of Geophysical Research (D) JGRDE3, Vol. 92, No. 4, p 3991-4000, April 1987. 12 fig, 21

Descriptors: \*Cloud classification, \*Dynamic threshold method, \*Satellite imagery, \*Cloud size, \*Data interpretation, Estimating, Remote sensing, Histograms, Cirrus, Oceans.

Histograms, Cirrus, Oceans.

A simple objective cloud type classification method has been developed, based on splitwindow measurements of the Advanced Very High Resolution Radiometer on board the NOAA 7 satellite. Brightness temperature difference between the split-window data is a good parameter for the detection of cirrus and blackbody clouds. Two-dimensional histograms of brightness temperature of the 11-micron channel and the brightness temperature difference between the split-window data over (64 km) squared subareas are constructed. By selecting appropriate thresholds in the two-dimensional histogram, cirrus, dense cirrus, cumulonimbus, and cumulus clouds are classified over the tropical ocean. Cloud type classification maps were generated by this method for the western Pacific Ocean and were compared with the nephanalysis chart constructed at the Japan Meteorological Satellite Center from GMS data collected within 1 hour of the NOAA 7 observations. The comparison shows reasonable agreement. Fractional cloud cover for cirrus over each (64 km) squared subarea is calculated as the ratio of the number of samples which belong to the cirrus cloud type in the two-dimensional histogram to the number of total samples in the subarea. Fractional cloud cover estimations for cumulonimbus and low-level cumulus are also presented. (Author's abstract) low-level cumulus are also presented. (Author's abstract) W87-09693

SURFACE-OBSERVED AND SATELLITE-RE-TRIEVED CLOUDINESS COMPARED FOR THE 1983 ISCCP SPECIAL STUDY AREA IN FUROPE

Liverpool Univ. (England). Dept. of Geography. A. Henderson-Sellers, G. Seze, F. Drake, and M.

Journal of Geophysical Research (D) JGRDE3, Vol. 92, No. 4, p 4019-4033, April 1987. 11 fig, 6 tab, 21 ref. USAF Grant AFOSR-85-0118.

Descriptors: \*Meteosat, \*Dynamic threshold method, \*Satellite imagery, \*Cloud size, \*Data interpretation, Estimating, Remote sensing, Cirrus, Clouds, Atmosphere.

A comparison has been undertaken between surface-observed total low- and high-cloud amount and retrievals from METEOSAT radiance data made using the cluster technique of Desbois et al. (1982). The aim of the study was to establish whether surface-observed cloud information could be usefully exploited to benefit satellite-based cloud retrievals. Observations from 124 surface stations at 1200 UT for the 20-day period from July 22 to August 10, 1983, were compared with retrievals made from METEOSAT radiances measured at 1130 UT. The comparisons for total and low-cloud amount are made for France and southern Britain. The high-cloud amount comparison was limited to 34 stations in southern Britain. The location and time period were selected to son was limited to 34 stations in southern Britain. The location and time period were selected to coincide with one of the regions designated for special study in the International Satellite Cloud Climatology Project (ISCCP) (Schiffer, 1982). For total cloud amount, 29% of the retrievals were fully in agreement with the surface observations and 64% of differences were within + or - 1 okta (+ or - eighth of sky cover). In the case of layer cloud amounts, 64% of the low-cloud amount differences and 50% of the high-cloud amount differences were within + or - 1 okta, although many of these successes (71% in the low-cloud amount differences were within + or - 1 okta, although many of these successes (71% in the low-cloud amount differences were within + or - 1 okta, although many of these successes (71% in the low-cloud amount differences were within + or - 1 okta, although many of these successes (71% in the low-cloud amount differences were within + or - 1 okta, although many of these successes (11% in the low-cloud amount differences were within + or - 1 okta, although many of these successes (11% in the low-cloud amount differences were within + or - 1 okta, although many of these successes (11% in the low-cloud amount differences were within + or - 1 okta, although many of these successes (11% in the low-cloud amount differences were within + or - 1 okta, although many of the low-cloud amount differences were within + or - 1 okta, although many of the low-cloud amount differences were within + or - 1 okta, although many of the low-cloud amount differences were within + or - 1 okta, although many of the low-cloud amount differences were within + or - 1 okta, although many of the low-cloud amount differences were within + or - 1 okta, although many of the low-cloud amount differences were within + or - 1 okta, although many of the low-cloud amount differences were within + or - 1 okta, although many of the low-cloud amount differences were within + or - 1 okta, although many of the low-cloud amount differences we thin cirrus which was not detected by the satellite retrieval and to detect small gaps in cloud decks and small clouds missed by the satellite retrieval. In addition, cloud retrievals in coastal locations seemed to be more successfully accomplished by surface observers than by the satellite retrieval algorithm used here, which does not take into account land-sea partition. (Author's abstract) W87-09694

CLOUD FIELDS RETRIEVED FACTOR SIS OF HIRS2/MSU SOUNDING DATA, CLOUD FIELDS RETRIEVED FROM ANALY-

SIS OF HIRSZ/MSU SOUNDING DATA, National Aeronautics and Space Administration, Greenbelt, MD. Lab. for Atmospheric Sciences. J. Susskind, D. Reuter, and M. T. Chahine. Journal of Geophysical Research (D) JGRDE3, Vol. 92, No. 4, p 4035-4050, April 1987. 4 fig. 11

Descriptors: \*HIR\$2/M\$U, \*Dynamic threshold method, \*Satellite imagery, \*Cloud size, \*Data interpretation, Estimating, Clouds, Atmosphere.

The methods used to determine effective cloud fraction (cloud fraction times cloud emissivity at 11-14 micron) and cloud top pressure from analysis of HIRSZ/MSU sounding data are described. Identical procedures are used day and night so as to allow for meaningful day-night difference fields. Results are shown for June 1979. The monthly mean effective cloud fraction is 43.4%, resulting from a 45.2% value at 0300 LT and 41.6% at 1500 LT. The retrieved single-day cloud field for June 11 shows good agreement with high spatial resolution visible and infrared imagery. (Author's ab-

CLOUD COVER OVER THE EQUATORIAL EASTERN PACIFIC DERIVED FROM JULY 1983 INTERNATIONAL SATELLITE CLOUD CLIMATOLOGY PROJECT DATA USING A HYBRID BISPECTRAL THRESHOLD

METHOD,
National Aeronautics and Space Administration,
Hampton, VA. Langley Research Center.
P. Minnis, E. F. Harrison, and G. G. Gibson.
Journal of Geophysical Research (D) JGRDE3,
Vol. 92, No. 4, p 4051-4073, April 1987. 13 fig. 2
to 27 ref engend. tab, 27 ref, append.

Descriptors: \*Bispectral threshold method, \*Dynamic threshold method, \*Satellite imagery, \*Cloud size, \*Data interpretation, Estimating, Remote sensing, Cirrus, Clouds, Temperature, Atmosphere, Histograms.

revised hybrid bispectral threshold method is A revised hyono ospectral threshols method is developed to improve retrievals of clear-sky and cloud-top temperatures, low-level cloud amounts, and thin cirrus clouds. These changes include the setting of constraints on the cloud albedo and the temperatures which may be included in the calculations. temperatures which may be included in the calcu-lations of clear-sky temperature and cloud amount. When any of the limits are exceeded, an alternative method is used for the determination of cloud amount from the two-dimensional visible-infrared histogram. The alternate method used depends on the type of constraint violated by the results from the standard cloud amount calculation. Even though it appears that the overall average cloud amount derived with the revised method is not much different than that which would have been much different than that which would have been derived from the original technique, the new methodology produced substantial changes in about one third of the cloud amount retrievals. Low cloud retrievals were affected most often by the new constraints. Thin, high clouds were detected in many instances when they would have been missed with the original methodology. The revised method was used to analyze a 15-day set of 3-hourly, 32-km resolution visible and infrared data aken with the GOES-West satellite over the tropical eastern Pacific for the International Satellite Cloud Climatology Project (ISCCP). Cloud amounts and albedos are similar to those derived from other data sets. Total and low cloud amounts in areas with trade cumulus and stratocumulus in areas with trade cumulus and stratocumulus fields were usually greatest in the early morning and at a minimum in the midafternoon. A harmon-ic analysis of mean 3-hourly cloudiness over the ic analysis of mean 3-hourly cloudiness over the trade and stratocumulus regions revealed a very strong diurnal component over both cloud types. A significant semidiurnal component was found over the trade cumulus regions. Its phase corre-sponds to the semidiurnal tide. The semidiurnal component was much weaker over the stratocumu-lus regions. Over the ITCZ and the areas where the tropical storms passed, high cloud amounts generally peaked during the midafternoon. The diurnal variations of midlevel clouds were marked by early morning maxima and midday minims. by early morning maxima and midday minima. (Alexander-PTT) W87-09696

ROLE OF EARTH RADIATION BUDGET STUDIES IN CLIMATE AND GENERAL CIR-CULATION RESEARCH,

National Center for Atmospheric Research, Boul-

National Center for Atmospheric Research, Boulder, CO. V. Ramanathan. Journal of Geophysical Research (D) JORDE3, Vol. 92, No. 4, p 4075-4095, April 1987. 19 fig. 2 tab, 74 ref. NASA ERBE Grant L9477B.

Descriptors: \*ERBE, \*Dynamic threshold method, \*Satellite imagery, \*Cloud size, \*Data interpreta-tion, Estimating, Remote sensing, Solar radiation, Model studies, Climate, Winds.

A remarkably simple and effective approach is proposed to address these types of problems, with the aid of the comprehensive radiation budget data collected by the Earth Radiation Budget Experi-ment (ERBE). ERBE is a multisatellite experiment ment (ERBE). ERBE is a multisatellite experiment which began collecting data in November 1984. The simple approach calls for the estimation of clear-sky fluxes from the high spatial resolution scanner measurements. A cloud-radiative forcing (or simply cloud forcing) is defined which is the difference between clear-sky and cloud-sky (clear plus overcast skies) fluxes. The global average of the sum of the solar and long-wave cloud forcing vields directly the net radiative effect (i.e., cooling the sum of the solar and long-wave cloud forcing yields directly the net radiative effect (i.e., cooling or warming) of clouds on climate. Furthermore, analyses of variations in clear-sky fluxes and the cloud forcing in terms of temperature variations would yield the radiation-temperature feedbacks, including the mysterious cloud feedback, that are needed to verify present theories of climate. Finally, general circulation model results are used to discuss the nature of the cloud radiative forcing. It is shown that the long-wave effect of clouds is to

#### Field 7—RESOURCES DATA

#### Group 7B-Data Acquisition

enhance the meridional heating gradient in the troposphere, while the albedo or solar effect of clouds is largely to reduce the available solar energy at the surface. The long-wave cloud-induced drive for the circulation is particularly large in the monsoon regions. Thus it is concluded that analyses of ERBE data in terms of cloud forcing would add much needed insights into the role of clouds in the general circulation. With respect to the future, the scientific need is discussed for continuing broadband measurements of earth radiation budget data into the next century in order to understand the processes that govern interannual and decadal climate trends. Finally, the spectral variations in clear-sky fluxes and cloud forcing and the need for broadband data to obtain the desired accuracies are described. (Alexander-PTT) W87-09697

CLOUD COVER ANALYSIS FROM SATELLITE IMAGERY USING SPATIAL AND TEM-PORAL CHARACTERISTICS OF THE DATA, Centre National de la Recherche Scientifique, Palaiseau (France). Lab. de Meteorologie Dynami-

G. Seze, and M. Desbois.
Journal of Climate and Applied Meteorology
JCAMEJ, Vol. 26, No. 2, p 287-303, February
1987. 13 fig, 6 tab, 20 ref.

Descriptors: \*Cloud classification, \*Statistical analysis, \*Dynamic threshold method, \*Satellite imagery, \*Cloud size, \*Data interpretation, Estimating, Remote sensing, Histograms, Spatial variation,

New developments of a cloud classification scheme based on histogram clustering by a statisti-cal method are presented. Use of time series of geostationary satellite pictures as well as for construction of composite images representative of the surface properties and then for the identification of significative cloud classes is discussed. Spatial varnces are introduced as additional parameters of the classification, with the aim to better separate clouds from the surface and the different kinds of more or less homogeneous cloud classes. (Author's abstract) W87-09704

REMOTE CONTROL OF HYDROMETEORO-REMOTE CONTROL LOGICAL DEVICES,
LOGICAL DEVICES,
Conter for Water Resources Research,

G. E. Hill, W. Lofthouse, H. Leineweber, and H.

G. E. Hill, W. LOHROUSE, H. LEHIEWEDER, and H. Rodrigues de Miranda. Available from the National Technical Information Service, Springfield, VA 22161, as PB86-168036/AS. Price codes: A03 in paper copy, A01 in microfiche. Atmospheric Water Resources Series WWRL/A-85/01. Program Report G-936-05, September 1985. 40 p, 4 fig. 8 tab. Contract No. 14-08-0001-G936. USGS Project No. G936-05.

Descriptors: \*Remote control, \*Data retrieval, \*Hydrometeorological devices, \*Utah, \*Telemetry, Communications, Cloud seeding, Hydrologic

The acquisition of data from remotely located sensors or the control of remotely located devices sors or the control of remotely located devices poses a practical problem in communication. In the present study various options for data acquisition and remote control for hydrometeorological applications are examined. These options include telemetry by radio (or telephone) using various modes of communication. The communication modes available include one and two way RF links, line-of-sight systems, repeaters, telephone, meteor scatter and satellite systems. Each of these approaches is examined according to availability of equipment, frequency allocations, costs and other factors. A frequency allocations, costs and other factors. A detailed description of a communication system for data acquisition for remotely located sensors is given. This low cost system combines RF and telephone. Much of the system is contained in the interfaces between the various main components. Similarly, another system for controlling remotely located devices is described. Both systems may be operated effectively in mountainous terrain as well as for other areas. (Hill-Utah St. Univ.-UCWRR)

W87-09766

MEASUREMENT OF IRRIGATION EVAPORA-TIVE LOSSES BY A NEW VAPOR BUDGET

Clemson Univ., SC. Dept. of Civil Engineering. P. Inmula, and B. L. Sill.

P. Inmula, and B. L. Sill.

Available from the National Technical Information Service, Springfield, VA 22161, as PB86-157112/
As. Price codes: A06 in paper copy, A01 in microfiche. South Carolina Water Resources Resent-Institute, Clemson. Report No. 117, September 1985. 100 p. 20 fig, 10 tab, 36 ref, 3 append. Contract No. 14-08-0001-G-868; 14-08-0001-G-932. USGS Project No. G-868-04-SC; G-932-04-SC.

Descriptors: \*Evaporation, \*Measuring instruments, \*Wind velocity, \*Water vapor, \*Water loss, \*South Carolina, Irrigation, Water budget.

The importance of evaporative losses in water resources planning is discussed, and an overall review of the existing methods for estimation of evaporation is presented. A new technique for short term measurement of evaporation from snort term measurement of evaporation from moist, rough surfaces (such as irrigated cropped areas) is developed based on a control volume concept: the difference in the fluxes of outgoing and incoming atmospheric water vapor is equal to and incoming atmospheric water vapor is equal to the evaporation rate. While the rigorous applica-tion of the vapor budget technique needs both upwind and downwind windspeed profiles, only one windspeed profile is considered, and the effect of this approximation is evaluated. Experimental observations were made at a test site of 100 feet square in area (located at the Simpson Agricultural Research Station of Clemson University) on a simulated irrigated cropped area. A vertical extent of 3 m was found to be sufficient for the evaluation of 3 m was found to be sufficient for the evaluation of moisture concentration profiles (7 elevations for each downwind profile). The windspeed power law profile was obtained by measuring the windspeed at 0.65 m and 3 m. An averaging time of 15 minutes was used for the evaluation of these profiles, and the averaging losses, was obstained by files, and the evaporation losses were obtained through numerical integration of the measured profiles. Simultaneous water budget measurements were made, and comparison of vapor budget evap-oration values with those of water budget evap-was evaluated. It was found for the present study that the vapor budget is accurate to within ap-proximately 12 percent for steady wind direction so long as the average of five profile sets was used for each 15 minute evaporation time. (Sill-WRRI) W87-09785

USING TIME DOMAIN REFLECTOMETRY TO MEASURE FROST DEPTH AND FROZEN

WATER CONTENT IN SOIL, Washington State Univ., Pullman. Dept. of Agronomy and Soils. D. J. Mulla.

Available from the National Technical Information Available from the National Technical information Service, Springfield, VA 22161, as PB86-157419/ AS. Price codes: A05 in paper copy, A01 in microfiche. State of Washington Water Research Center, Pullman. Project Completion Report No. 64, June 1985. 80 p. 36 fig. 14 ref. Contract No. 14-08-0001-G940. USGS Project No. G940-05 (A-129-WASH) WASH

Descriptors: \*Soil water, \*Frozen ground, \*Frost, \*Washington, Soil temperature, Soil conservation, Soil erosion, Agricultural runoff.

Field research using the technique of time domain reflectometry (TDR) was conducted from December 1984 to March 1985 to monitor unfrozen water content and frost depth in soils under the following conditions: vertical steel TDR probes were in continuous, long-term use with relatively long transmission cables, and TDR probes used to monitor unfrozen water content and frost depth in soils seeded to winter wheat and having the following surface management and tillage practices: (1) conventional tillage with a mold-board plot, (2) no tillage with fall seeding using a no-till dril, and (3) bare-surface, continuous fallow tillage. TDR calibration curves relating soil volumetric water content to apparent dielectric constant of the unfrozen tent to apparent dielectric constant of the unfrozen soil water were used to compute unfrozen volu-

metric water content in each of the plots during each of several freeze-thaw episodes. During peri-ods of surface thawing, measurements of unfrozen water content increased as ice melted. The TDR results for unfrozen water content in the surface layer ranged from 5-15%, 5-25%, 5-20% in the fallow, no-till, and moldboard plow plots, respec-tively. These results are consistent with frost tube and soil temperature measurements, which indicate that frost penetration was deeper and longer in duration for the fallow and moldboard plowed plots than for the no-till plot. A comparison of soil temperature measurements showed that the insulating effect of straw residue at the soil surface in the no-till plot not only prevented deep frost penetra-tion and produced relatively wet soil surface conditions during December and January, it also retarded soil warming compared to the fallow and moldboard plowed plots in February and March. (Mulla-WSU)

INDEX OF SURFACE-WATER STATIONS IN TEXAS, JANUARY 1986, Geological Survey, Austin, TX. Water Resources

E. R. Carrillo, H. D. Buckner, and J. Rawson. Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 86-235, 1986.

16 p. 2 plates, 1 tab

Descriptors: \*Gaging stations, \*Texas, \*Surface-water stations, \*Water measurement, Maps, Net-

As of January 1, 1986, the surface-water data-collection network in Texas operated by the U.S. Geological Survey included 386 streamflow, 87 reservoir-contents, 33 stage, 10 crest-stage partial-record, 8 periodic discharge through range, 38 flood-hydrograph partial-record, 11 flood-profile partial-record, 36 low-flow partial-record 2 tide-level, 45 daily chemical-quality, 23 continuous-recording water-quality, 97 periodic biological, 19 lake surveys, 174 periodic organic- and (or) nutri-ent, 4 periodic insecticide, 58 periodic pesticide, 22 automatic sambler, 157 periodic impor elements. automatic sampler, 157 periodic minor elements, 141 periodic chemical-quality, 108 periodic physical-organic, 14 continuous-recording three- or four-parameter water-quality, 3 sediment, 39 periodic sediment, 26 continuous-recording temperature, and 37 national stream-quality accounting network stations were in operation. Tables describnetwork stations were in operation. Tables describ-ing the station location, type of data collected, and place where data are available are included, as well as maps showing the location of most of the sta-tions. (USGS) W87-09817

APPLICATION OF BOREHOLE ACOUSTIC METHODS IN THE CHARACTERIZATION OF DEEPLY BURIED BASALT FLOWS, Geological Survey, Denver, CO. Water Resources

Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Open File Report 85-419, 1985. 90 p, 49 fig, 2 tab, 30 ref.

Descriptors: \*Borehole geophysics, \*Geohydrology, \*Geologic fractures, \*Basalt aquifers, Acoustics, Well logs, Borehole-wall breakouts, Acoustic

Acoustic-waveform and acoustic-televiewer logs were obtained for a 400-meter interval of deeply buried basalt flows in three boreholes, and over shorter intervals in two additional boreholes located on the U.S. Department of Energy's Hanford site in Benton County, Washington. Borehole-wall breakouts were observed in the unaltered interiors oreasouts were observed in the unaitered interiors of a large part of individual basalt flows; however, several of the flows in one of the five boreholes had almost no breakouts. The distribution of breakouts observed on the televiewer logs correlated closely with the incidence of core disking in some intervals, but the correlation was not always perfect, perhaps because of the differences in the specific fracture mechanisms involved. Boreholewall breakouts were consistently located on the east and west sides of the boreholes. The orienta-

### Data Acquisition—Group 7B

tion is consistent with previous estimates of the principal horizontal-stress field in south-central Washington, if breakouts are assumed to form along the azimuth of the least principal stress. The Washington, if breakouts are assumed to form along the azimuth of the least principal stress. The distribution of breakouts repeatedly indicated an interval of breakout-free rock at the top and bottom of flows. Because breakouts frequently terminate at major low-angle fractures, the data indicate that fracturing may have relieved some of the horizontal stresses near flow tops and bottoms. Unaltered and unfractured basalt appeared to have a uniform compressional velocity of 6.0 + or -0.1 km/sec throughout flow interiors. Acousticavaveform logs also indicated that borehole-wall breakouts did not affect acoustic propagation along the borehole; so fracturing associated with the formation of breakouts appeared to be confined to a thin annulus of stress concentration around the borehole. Televiewer logs obtained before and after hydraulic fracturing in these boreholes indicated the extent of induced fractures, and also indicated minor changes to pre-existing fracture generation, (USGS) eration. (USGS) W87-09829

PRINCIPAL FACTS FOR GRAVITY STATIONS IN PARADISE AND STAGECOACH VALLEYS, HUMBOLDT AND LYON COUNTIES,

NEVADA, Geological Survey, Carson City, NV. Water Re-For primary bibliographic entry see Field 7C. W87-09842

ESTIMATING IRON AND ALUMINUM CONTENT OF ACID MINE DISCHARGE BY USE OF ACIDITY TITRATION CURVES, Geological Survey, Harrisburg, PA. Water Re-

s Div. A. N. Ott.

A. N. Ott. Available from USGS, OFSS, Box 25425, Denver, CO 80225. USGS Water-Resources Investigations Report 84-4335, 1986. 25 p, 7 fig, 9 tab, 9 ref.

Descriptors: \*Water quality, \*Acid mine drainage, \*Acidity, \*Metals, \*Water pollution sources, \*Pennsylvania, Tioga County.

Determination of acidity provides a value that denotes the quantitative capacity of the sample water to neutralize a strong base to a particular pH. However, much additional information can be obtained from this determination if a titration curve is constructed from recorded data of titrant increments and their corresponding pH values The curve can be used to identify buffer capabili-The curve can be used to identify burier capaonities, the acidity with respect to any pH value within the curve limit, and, in the case of acid mine drainage from north-central Pennsylvania, the identification and estimation of the concentration of dissolved ferrous iron, ferric iron, and aluming Through use of itiration curves, a relationof dissolved ferrous iron, ferric iron, and aluminum. Through use of titration curves, a relationship was observed for the acid mine drainage between: (1) the titratable acidity (as milligrams per liter calcium carbonate) to pH 4.0 and the concentration of dissolved ferric iron; and (2) the titratable acidity (as milligrams per liter of calcium carbonate) from pH 4.0 to 5.0 and the concentration of dissolved aluminum. The presence of dissolved ferrous iron and adverted busine buffering effects. of dissolved aluminum. The presence of dissolved ferrous iron can be detected by the buffering effect exhibited in the area between pH 5.5 to 7.5. The concentration of ferrous is estimated by difference concentration of terrous is estimated by difference between the concentrations of ferric iron in an oxidized and unoxidized sample. Interferences in any of the titrations from manganese, magnesium, and aluminate, appear to be negligible within the pH range of interest. (USGS)

EMPIRICAL ANALYSIS OF PASSIVE MICRO-WAVE OBSERVATIONS FROM BHASKARA-II SAMIR AND REMOTE SENSING OF ATMOS-PHERIC WATER VAPOR AND LIQUID WATER.

Indian Space Research Organization, Ahmedabad. Space Ar Sications Centre

Journal et Climate and Applied Meteorology

JCAMEJ, Vol. 26, No. 1, p 3-17, January 1987. 10

Descriptors: \*Data acquisition, \*Microwaves, \*Remote sensing, \*Atmospheric water, \*Water vapor, Satellite technology, Sensors, Mathematical equations, Mathematical studies, Statistical methods, Measuring instruments, Tropical regions.

Empirical and statistical techniques were used to examine a large dataset of near-nadir brightness temperature measurements at 19, 22 and 31 GHz over tropical oceans from the Satellite Microwave Radiometer (SAMIR) system onboard the Bhasara-II satellite. Total water vapor data from NOAA-7 satellite were used in an empirical correlation analysis in conjunction with the near-coincident SAMIR data to establish statistical relationships between brightness temperature and total water vapor under cloud-free conditions. Bispectral distributions of the SAMIR data were analyzed through a partially supervised cluster analyzed tral distributions of the SAMIR data were analyzed through a partially supervised cluster analysis technique to separate the liquid water contaminated data based on their spectral response. From this analysis, approximate threshold brightness temperature values for the three SAMIR channels were fixed, above which cloud liquid water effect dominates. In order to verify these threshold values, limited SAMIR data related to cloudy conditions were examined in conjunction with the values, limited SAMIR data related to cloudy conditions were examined in conjunction with the NOAA-7 satellite cloud imageries. A reasonable qualitative spatial correlation was found between the cloudy regions, identified on the basis of the SAMIR threshold values, and the satellite cloud observations. Finally, using a simple scheme, an approximate regression equation was derived for estimating atmospheric liquid water content over an ocean from the SAMIR data. Liquid water estimates for a few cases were made to illustrate estimates for a few cases were made to illustrate. estimates for a few cases were made to illustrate the simplified approach. (Author's abstract) W87-09909

SOIL MOISTURE ESTIMATION USING GOES-VISSR INFRARED DATA: A CASE STUDY WITH A SIMPLE STATISTICAL MODEL,

National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. P. J. Wetzel, and R. H. Woodward. Journal of Climate and Applied Meteorology JCAMEJ, Vol. 26, No. 1, p 107-117, January 1987. 8 fig, 1 tab, 25 ref.

Descriptors: \*Remote sensing, \*Infrared imagery, \*Soil moisture, \*Statistical methods, \*Satellite technology, \*Model studies, Mathematical studies, Kansas, Nebraska, Soil temperature, Temperature, Numerical model, Surface temperature, Regression analysis, Estimating.

Five days of clear sky observations over Kansas and Nebraska are used to examine the statistical relationship between soil moisture and infrared surface temperature observations taken from a geosynchronous satellite. The approach relies on numerical model results to identify important variables other than soil moisture which have a significant effect on the surface temperature, and to define linear relationships between these variables and surface temperature. Linear regression is used to relate soil moisture to surface temperature and other variables that represent wind speed, vegetation cover, and low-level temperature advection. Results show good agreement between estimated and observed soil moisture features on each of the 5 days. The average coefficient of determination results snow good agreement between estimated and observed soil moisture features on each of the 5 days. The average coefficient of determination for five pseudo-independent tests in which the test day is held out of the regression is 0.71. When advection is neglected in these tests the average value of r squared drops to 0.57. It is shown that a depletion coefficient of 0.92, when used to compute antecedent precipitation index (API), produces the best correlation between API and soil moisture as inferred from GOES thermal infrared data. By averaging daily predicted values over the 5-day rain-free case study period, 92% of the variance of the morning surface temperature change is explained by a simple linear regression with all independent variables, or, alternatively, 85% of the observed variance in API is explained. It is concluded that this approach can distinguish at least four classes of soil wetness, but the necessity for measurement of surface advection may limit its usefulness in remote areas. (Author's abstract)

W87-09913

METHODS FOR STUDY OF RAINDROP IMPACT ON PLANT SURFACES WITH APPLICATION TO PREDICTING INOCULUM DISPERSAL BY RAIN, Ohio State Univ., Columbus. Dept. of Plant Pa-

K. M. Reynolds, L. V. Madden, D. L. Reichard, and M. A. Ellis.

Phytopathology PHYTAJ, Vol. 77, No. 2, p 226-232, February 1987. 5 fig, 2 tab, 32 ref.

Descriptors: \*Plant pathology, \*Data acquisition, \*Raindrop impact, \*Rainfall, \*Drop generator, \*Splash dispersal, \*Plant pathology, \*Leaves, Prediction, Photography, Fluid drops.

Because of the importance of rain impact in the liberation and dispersal of inoculum of many fungal and bacterial plant pathogens, modifications to the method of generating single drops of a specified size representing the entire raindrop spectrum were made to facilitate studies in this area. rum were made to facilitate studies in this area. The drop-generating and photographic system which supplies detailed information on splash dispersal events produces uniform drops 0.18-1.89 mm in diameter using a piezoelectric crystal. Larger drops (2.16-3.24 mm diameter) were produced by a solenoid pump. The drop generator activation signal is used to activate a microprocessor-controlled timing circuit that can trigger-up seven strobe lamps for use in multiple-exposure photography. A primary, programmable delay is used to control the start of the flash sequence. Delay between flashes is controlled by the frequency of an oscillator signal input to the timer. Strobe sequences can be used to determine the velocity, size and number of droplets formed by a splash crown. (Wood-PTT) (Wood-PTT) W87-09921

PROPOSED APPLICATION OF AUTOMATED BIOMONITORING FOR RAPID DETECTION OF TOXIC SUBSTANCES IN WATER SUP-PLIES FOR PERMANENT SPACE STATIONS, Tennessee Technological Univ., Cookeville. E. L. Morgan, R. C. Young, M. D. Smith, and K. W. Eagleson.
Journal of Environmental Sciences, Vol. 30, No. 2, 47-49, March April 1987. 3 fig, 10 ref.

Descriptors: \*Data acquisition, \*Bioindicators, \*Measuring instruments, \*Pollutant identification, \*Monitoring, \*Water quality, \*Drinking water, \*Space stations, Water quality management, Toxins, Poisons, Hazardous materials, Computers, Mussels, Invertebrates.

Proposed design characteristics and applications of automated biomonitoring devices for real-time toxicity detection in drinking water supplies on-board permanent space stations were presented. Tests in transmissions of automated biomonitoring data to earth-receiving stations were simulated using satelite linkage from remote earth-based stations. Automated biomonitoring can provide real-time physiological response information resulting from cause/effect relationships between toxicants and selected aquatic animals. Because the reliability of information from a single species or from specific cause/effect relationships between toxicants and selected aquatic animals. Because the reliability of information from a single species or from specific physical/chemical water quality parameters may not provide comprehensive protection from a wide variety of potentially toxic compounds, a computer-assisted multiple species biosensing system was developed. Emphasis was placed on developing methods for detecting species-specific bioelectric potentials produced by unrestrained bivalve mussels and other sedentary invertebrates since these animals are presumably more easily maintained in near zero gravity than fish. In achieving this objective, differential amplifiers were constructed for measuring a wide range of responses signals induced by various biological activities from fish and invertebrate subjects. Specific responses were detected as discrete analog signals, each converted to a digital voltage, and filed in computer storage. A management program provided various means for data gathering, filing, and retrieval. (Author's abstract)
W87-09925 W87-09925

#### Group 7B-Data Acquisition

ORIGIN OF GROWTH-INDUCED WATER PO-TENTIAL: SALT CONCENTRATION IS LOW IN APOPLAST OF ENLARGING TISSUE, Texas A and M Univ., College Station. Dept. of Texas A and M. Const., Soil and Crop Sciences. For primary bibliographic entry see Field 2I.

SATELLITE HYDROLOGY.

Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. 730 p. Edited by Morris Deutsch, Donald R. Wiesnet, and Albert Rango.

Descriptors: \*Hydrologic cycle, \*Hydrologic data, \*Satellite technology, \*Symposium, \*Remote sens-ing, Conferences, Evaporation, Precipitation, Rain-fall-runoff relationships.

The collection of papers bound together between the covers of this volume represents the most comprehensive attempt yet made to show the impact of artificial satellites on the science of hy-drology. In June 1973, the American Water Works Association appropriate a Symposium at Burlington drology. In June 1973, the American water Works
Association sponsored a Symposium at Burlington,
Ontario, Canada, at the Canada Center for Inland
Waters on 'Remote Sensing and Water Resources
Management.' The 1979 Pecora Symposium was
also sponsored by the American Water Resources
Association and was even more successful with
seeds 4400 participants from 12 countries and 120 association and was even in the successful with nearly 400 participants from 12 countries and 120 papers presented. The hydrologic cycle is well known to every earth science student, who will recall the familiar diagram showing (with arrows) the passage of water as it evaporates from the ocean's surface, rises as vapor, condenses as clouds, falls as precipitation onto the land, where if it does not run off into rivers - it sinks into the ground only to seep out later in springs or brooks, to return ultimately to the ocean and there to begin the cycle anew. This volume on Satellite Hydrology reflects the hydrologic cycle beginning with precipitation, i.e., hydrometeorology. (See W87-09954 through W87-10043) (Lantz-FTT)

REMOTE SENSING IN HYDROLOGY - A CHALLENGE TO SCIENTISTS,

CHALLENGE 10 SCIENTISTS, Geological Survey, Reston, VA. J. S. Cragwall. IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 3-5.

Descriptors: \*Remote sensing, \*Hydrologic cycle, \*Satellite technology, \*Data acquisition, \*Hydrology. Water resources management.

The recently acquired capabilities of remote sensing have conferred important advantages on all earth sciences, including hydrology. Synoptic viewing, repetitive imaging, relative low cost, and an approach to real-time reporting are being utilized in many applications of water resources investigations. Among these applications are shallow groundwater exploration, inventorying surface groundwater exploration, inventorying surface waters, improvement in estimates of water withdrawal and consumption, assessment of sea and polar ice conditions, and the relay of hydrologic data to collecting points by satellite. Much work remains to be done, including the development of an improved ability to incorporate land surface features into hydrologic models, which means solving the associated problems of large-scale data corresponding to the processing. These may be susceptible storage and processing. These may be susceptible to resolution by the hydrologic modeling principal components technique. (See also W87-09953) (Author's abstract) W87-09954

SATELLITE APPLICATIONS IN RIVER AND FLOOD FORECASTING,
National Weather Service, Silver Spring, MD.

Office of Hydrology.

Office of Hydrology.

R. A. Clark.

IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,

June 10-15, 1979. 1981. p 6-8.

Descriptors: \*Hydrologic data, \*Satellite technology, \*River flow, \*Flood forecasting, \*Data acquisition, \*Remote sensing, Rainfall-runoff relationships, Precipitation, Forecasting, Snow, Soil water.

Today the river and flood forecasting service pro-Today the river and flood forecasting service produces annually over 400,000 forecasts for some 2,500 riverside communities. These forecasts are prepared by 13 River Forecast Centers located throughout the United States. Dissemination is made through Weather Service Forecast Offices (WSFC'9), generally one in each State designated as Hydrologic Program Offices. These offices keep abreast of the needs of users as well as changes such as water management structures that may affect river forecasts. They also collect hydrologic data from some 7,000 river and rainfall observation affect river forestasts. Iney asso collect river forestasts. Iney asso collect river forestasts. Included that from some 7,000 river and rainfall observation points. Floods currently cause nearly 200 deaths annually and over \$2 billion in damages. In recent years they have become the major cause of natural disaster in the United States. Discussed here are several applications of satellities to river and flood forecasting are described. Areas in which satellites offer a great potential for improved forecasts include areal estimates of snow cover, data relay, improved rainfall estimates in data sparse regions, and better definition of areal variation of soil moisture. (See also W87-09953) (Lantz-PTT) W87-09953

NASA WATER RESOURCES/HYDROLOGY REMOTE SENSING PROGRAM IN THE

1980'S, National Aeronautics and Space Administration,

Washington, DC.
M. A. Calabrese, and P. G. Thome.

M. A. Caiaorese, and F. G. Inone. IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 9-15, 14 fig, 20 ref.

Descriptors: \*Water resources development, \*Hydrologic cycle, \*Remote sensing, \*Data acquisi-DESCRIPTION: "Water resources development, "Hydrologic cycle, "Remote sensing, "Data acquisition, "Hydrologic data, "Satellite technology, Future planning, Computer programs, Monitoring, Thermal radiation.

Water Resources Managers are in need of im-proved information to better match geographical distributions and availability of water resources with needs and demands. Remote sensing can improve this information base by providing repetitive monitoring of large areas to complement conven-tional data sources. Established applications in hy-drologic watershed characterization are based on unultispectral scanner (MSS) data and will be improved with the advent of the Thematic Mapper (TM). The use of microwave and thermal infrared techniques show promise for soil and snow moisture monitoring. Hydrologic model improvements are needed in parallel with advances in remote sensing techniques to properly exploit these data. Future thrusts include the development of remote sensing techniques for evaportanspiration estimation, and the use of multilinear arrays sensors with microwave sensors for improved data acquisition (See also W87-09953) (Author's abstract)

CORPS OF ENGINEERS UTILIZATION OF SATELLITES FOR HYDROLOGIC PURPOSES, Corps of Engineers, Washington, DC. Hydraulics

and Hydrology Branch

and Hydrology Branch.
V. K. Hagen.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 16-18.

Descriptors: "Hydrologic data, "Corps of Engineers, "Satellite technology, "Hydrologic cycle, "Remote sensing, "Data acquisition, Water resources development, Rainfall-runoff relationships, Flooding, Forecasting, Water management, Monitoring, Soil water.

The U.S. Army Corps of Engineers use of satellites for hydrologic purposes has gradually increased since its initial experiment in 1972. Rapid transmis-

sion of environmental data from remote sensors has been the primary activity pursued by the Corps. Two ground receiving stations are operated by field offices in Waltham, Massachusetts, and Vicksburg, Mississippi. Satellite imagery is also utilized to hydrologic purposes. Information obtained in this manner contributes to water control management, runoff estimating, obtaining land use, monitoring changes, identifying flooded areas, locating important features such as dams and lakes, and other important activities. The Corps is engaged in research projects which will enhance the use of satellites in the field of hydrology. Most of the research relates to improved sensors or advanced applications of satellite imagery. (See also W87-09953) (Author's abstract)

AGRICULTURE'S NEEDS RELATED TO SAT-ELLITE HYDROLOGY,
Agricultural Research Service, Beltsville, MD.
Plant Physiology Inst.

Plant rnyslology Inst.
E. T. Engman.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 19-25, 5 fig, 10 ref.

Descriptors: \*Satellite technology, \*Agriculture, \*Water resources development, \*Data acquisition, \*Hydrologic data, \*Remote sensing, Hydrologic cycle, ARISTARS, Monitoring, Runoff, Soil water, Irrigation.

Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing, known as ARISTARS, is a cooperative research program of research, development, evaluation, and application of aerospace remote sensing for agriculture. This program is explained and its hydrologic applications, needs, and related activities are discussed. tions, needs, and related activities are discussed.

Among the research needs identified in AgRISTARS are several challenges to hydrologists that are discussed with samples. These include studying relationships between point and areal data and relationships between point and areal data and developing means of extrapolating point information as representative of large areas, directly measuring runoff (or infiltration) coefficients, detecting frozen soils, detecting and monitoring soil moisture and drought, irrigation scheduling, the possibility of using feedback from space platforms to improve prediction models, and developing soil-moisture-profile models that utilize remote sensing information. (See also W87-09953) (Author's abstract)

REVIEW OF CANADA'S PRESENT AND FUTURE REMOTE SENSING ACTIVITIES RELATING TO HYDROLOGY,

National Hydrology Research Inst., Ottawa (On-

I.S. Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 26-32, 19 fig, 12 ref.

Descriptors: \*Remote sensing, \*Hydrologic data, \*Canada, \*Future planning, \*Satellite technology, Data acquisition, Aircraft.

The Canada Center for Remote Sensing, or CCRS as it is usually known, remains the cornerstone of remote sensing in Canada. It maintains the satellite receiving stations at Prince Albert, in Saskatchewan, and at Shoe Cove, in Newfoundland. These stations receive NOAA, TIROS, GOES, and LANDSAT data, and last year Shoe Cover also collected SEASAT data during the three months that the satellite was operational. CCRS also has a fleet of four aircraft. This paper reviews these and other technical resources in Canada for acquisitioning and processing remotely sensed data, with particular attention to airborne and satellite borne instrumentation, satellite data reception, and data instrumentation, satellite data reception, and data analysis systems used by various agencies. It then goes on to give examples of application of these data from various subdisciplines of hydrology. (See also W87-09953) (Lantz-PTT) W87-09959

## Data Acquisition—Group 7B

SATELLITE VERSUS METHODS IN HYDROLOGY CONVENTIONAL

Geological Survey, Reston, D. G. Anderson.

D. C. Anderson.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 33-36, 21 ref.

Descriptors: \*Satellite technology, \*Hydrologic data, \*Data acquisition, \*Remote sensing, Forecasting, Water resources development, Hydrologic cycle, Hydrologic data.

cycle, Hydrologic data.

Scientists engaged in early applications of satellite hydrology first considered replacing conventional methods with analyses of data from satellites in expectation of saving time and money. This remains a valid objective, but increased emphasis has been placed on the complementary nature of detailed point data and synoptic information of a large area obtained repetitively by satellites. In some cases, for example polar research and weather forecasting, vast areas can be analyzed quickly based upon general background knowledge and data from satellites. A challenge is given to hydrologists to utilize data from satellites to solve problems involving large areas, environmental trends, and analysis of hydrologic systems. Such applications will tend to maximize the unique capabilities of satellite data to attack problems that cannot be solved by conventional methods alone. (See also W87-09953) (Author's abstract)

## INTRODUCTION TO SATELLITE HYDROLO-

GY, EROS Data Center, Sioux Falls, SD.

EROS Data Center, SIOUX PAUS, SD.

G. K. Moore.

IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 37-41, 1 tab, 5 ref.

Descriptors: \*Satellite technology, \*Hydrologic data, \*Data acquisition, \*Remote sensing, History, Water resources development, Hydrologic data, Computer programs

Remote sensing is the use of electromagnetic energy to inventory resources, monitor the environment, solve problems, and plan future actions. The science of remote sensing originated in the 1940's. Application to resource problems began in the 1960's and continued rapid growth through the 1970's. This progress included research on new types of data, satellite acquisition of data, digital methods of data processing, and determination of information content. Because of this research, 23 remote sensing applications are now operational in information content. Because of this research, 23 remote sensing applications are now operational in the field of hydrology. In the future, satellite remote sensing will become a routine, essential part of many hydrologic studies. New types of hydrologic models use atmospheric and surface information from a geographic data base for hydrologic predictions. The only practical method of acquiring repetitive data to update these models is by orbiting or geostationary satellites. (See also W87-09953) (Author's abstract)

GOES DATA COLLECTION SYSTEM,

National Environmental Satellite, Data, and Information Service, Washington, DC.

M. L. Neison.
IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 45-47.

Descriptors: \*Data acquisition, \*GOES, \*Satellite technology, \*Remote sensing, \*Hydrologic data,

The GOES Data Collection System (DCS) is a satellite based system for the collection of a large variety of environmental data obtained from virtually any point in the Western Hemisphere. The National Environmental Satellite Service (NESS), Department of Commerce, is the operator of the system. It has been providing services to users of

the system since 1974. The basic configuration of the system is identified by describing the major elements and their functions. The basic design crielements and their functions. The basic design criteria, together with system development has led to a truly operational program. NESS and many users have accumulated years of experience with this program so that is now possible to identify the useful features. This background also has made it possible for NESS and the users to plan for additional capabilities. System improvements and how they benefit the users are explained. Finally, the growth of the system in terms of number of platforms and users are given. (See also W87-09953) (Lantz-PTT) W87-09962

ADAPTING GOES DCS FOR USE BY CORPS OF ENGINEERS, Corps of Engineers, Waltham, MA. New England

T. D. Buckele 11. D. Buckelew.

In: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 48-50, 1 ref.

Descriptors: \*Data acquisition, \*GOES, \*Satellite technology, \*Remote sensing, \*Corps of Engineers, \*Hydrologic data, \*Hydrology, Hydrometeorology, Forecasting.

teorology, Forecasting.

Mew England Division, Corps of Engineers, working with private industry, has demonstrated a random reporting capability for collecting data using a standard 1500 Hz channel on NOAA's Geostationary Environmental Operational Satellite (GOES). The new mode has several advantages over scheduled or interrogation modes used to collect hydrometeorologic data required in reservoir regulation. The need for these data is especially critical during severe weather and flood situations, and data collection system (DCS) should be responsive to critical events. Previously available satellite systems of data collection have not sufficed for smaller watersheds and application in New England. In the random reporting system, hundreds of data collection platforms (DCP's) transmit on a single channel at proper time intervals to ensure an acceptable probability of reception. Several techniques have been incorporated to improve reception probabilities, the main ones being a short message (less than 3 seconds) and an adaptive algorithm programmed into each platform. This algorithm assures sufficient transmissions during critical times, yet relieves the system of superfluous messages during leives the system of superfluous messages during into each plantistic and the approximation and the control of the mation has been generated. The demonstration has confirmed that, even without the adaptive feature, at least 200 platforms will report successfully (with 90% probability) within an hour; and the research has revealed future enhancements which could increase the number of platforms by an order of magnitude. A new platform designed around readily available components is now operable and is expected to bring equipment costs within reach of many users. (See also W87-09953) (Author's abstract) stract) W87-09963

SATELLITE TELEMETRY OF HYDROLOGIC

SATELLITE TELEMETRY OF HYDROLOGIC DATA IN CALIFORNIA,
California State Dept. of Water Resources, Sacramento. Div. of Flood Management.
C. A. McCullough.
IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sious Falls, South Dakota, June 10-15, 1979. 1981. p 51-53.

Descriptors: \*Satellite technology, \*Telemetry, \*Hydrologic data, \*Hydrology, \*California, \*Remote sensing, \*Data acquisition, Precipitation, Rain gages, Snow, Rainfall, Computers, Stream-

Telemetry of hydrologic data in California is beginning to use a satellite as part of the communica-tion path. At present a snow water content sensor and ten precipitation gages report through a satel-

lite. In addition, Fire weather data passes through the satellite to aid in suppression of forest and range fires. Large amounts of real-time data are essential to water management and include stream-flow, precipitation, wind, snow water content, temperature, water quality, and reservoir stage. The present system collects data from about 180 The present system collects data from about 180 locations, part of which are tied into a computer. Eventually it will process all the data. The emphasis is on real-time data for flood forecasting, water supply forecasting, and water operations. Use of satellites eliminates radio path problems in mountain terrain and decreases use of mountaintop repeaters that are subject to climatic problems. Changes in the satellite facilities available to us are needed to achieve real-time data acquisition cases. needed to achieve real-time data acquisition capability. (See also W87-09953) (Author's abstract) W87-09964

MONITORING CANADA'S WATER RE-SOURCES IN REMOTE REGIONS BY SATEL-LITE TELEMETRY, Water Survey of Canada, Ottawa (Ontario). I. A. Reid, C. Pesant, and B. E. Goodison. IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing. Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 54-59, 17 ref.

Descriptors: "Hydrology, "Hydrologic data, "Satellite technology, "Telemetry, "Canada, Monitoring, "Remote sensing, "Data acquisition, Hydrometeorology, Forecasting, Flood forecasting, River forecasting, Precipitation.

Canada is a large country (nearly 10,000,000 sq km) with a small population (23,000,000) concentrated near the United States-Canada border. Increased economic activity in remote regions of the country has resulted in a demand for more hydrometeorological data, particularly on a real-time basis, in order to monitor meteorological conditions, to manage and operate water-resource projects, to forecast floods and river levels or to assess man's impact on the environment. Satellite telemetry is one method which has enabled users to obtain near real-time readings year round from unattended remotely located Data Collection Platforms (DCPs). Canada's experience over the last seven years, particularly with respect to hydrometric operations, has shown that data collection by satellite can be reliable and cost effective. Currenting the federal government has about 50 DCPs in ric operations, has shown that data collection by satellite can be reliable and cost effective. Currently, the federal government has about 50 DCPs in operation, the province of Quebec has 35 and private industry 20. Rapid expansion of land based hydrometeorological and buoy DCP networks is planned by federal and provincial agencies over the next few years. With the advent of the new generation of microprocessor controlled DCPs suitable for the Canadian climate, DCPs designed for hydrometric, water quality and meteorological (temperature, humidity, pressure, wind, precipitation) data acquisition will become an important means of obtaining data from remote locations. Adaptation to this new technology both by management and field staff will be required if telemetry is to utilized to its fullest potential. (See also W87-09953) (Author's abstract) 09953) (Author's abstract) W87-09965

U.S. GEOLOGICAL SURVEY APPLICATION OF SATELLITE TELEMETRY FOR THE SUPPORT OF HYDROLOGIC DATA COLLEC-

TION,
Geological Survey, Reston, VA.
W. G. Shope, and R. W. Paulson.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 60-64, 2 fig, 3 ref.

Descriptors: \*Satellite technology, \*Telemetry, \*Data acquisition, \*WATSTORE, \*Hydrologic data, \*Remote sensing, Geological Survey, Computer programs, Data collections.

The Water Resources Division of the U.S. Geological Survey is currently operating a network of more than 9,000 remote field sites for the continu-ous collection of hydrologic data. The Survey also operates a nationwide telecommunications net-

#### Group 7B-Data Acquisition

work that supports the entry and retrieval of data from the computerized National Water Data Storage and Retrieval System (WATSTORE). The two networks are currently linked by a manual data acquisition system that results in a 4 to 6-week data acquisition system that results in a 4 to 6-week delay between data collection and dissemination to the user community. The Geological Survey is involved with several research projects designed to bridge the network gap through further automation, including satellite telemetry of hydrologic data from remote sites. Some of the most promising benefits in the use of satellite telemetry include improved network management, real-time transfer of data, saving manpower, and the timely delivery of critical hydrologic data to the user community. In order to evaluate this new technology, the of critical hydrologic data to the user community. In order to evaluate this new technology, the Survey is currently evaluating the capabilities, design, and performance of three satellite data collection systems (DCS). These include the National Aeronautics and Space Administration's (NASA) Landsat series, the National Oceanic and Atmospheric Administration's (NOAA) Geostationary Operational Environmental Satellite (GOES), and a commercial demonstration conducted by COMSAT General (CG). (See also W87-09953) (Author's abstract)

ADVANCED TECHNOLOGY FOR SATELLITE

ADVANCED TECHNOLOGY FOR SAFELLITE DATA COLLECTION SYSTEMS, National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. C. E. Cote, and J. E. Painter.

C. D. Cote, and J. E. Painter.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 65-67, 1 tab, 6 ref.

Descriptors: \*Hydrology, \*Satellite technology, \*Data acquisition, \*Data collections, \*Remote sensing, Economic aspects, Data transmission, Electromagnetic waves, Future planning.

The advantage of the satellite for data collection/position location system (DC/PLS) functions was demonstrated by experimental systems aboard the Nimbus and Landsat series of spacecraft and is now operational aboard the TIROS and GOES (Geostationary Operational Environmental Satellite) spacecraft. These technological developments in satellite data collection are aimed at relieving contraints of positions understanding the contraints of position systems. in satellite data collection are aimed at relieving constraints of existing systems to permit expanded capability at lower costs in future operations. Constraints imposed by the limited electromagnetic spectrum available in the UHF band and the cost of user equipment are principal targets for imspectrum available in the UHF band and the cost of user equipment are principal targets for im-provement through technology. This paper de-acribes ongoing developmental activities in system and component areas which will become available for the next generation operations. (See also W87-09953) (Lantz-PTT)

SATELLITE DERIVED TECHNIQUE FOR ES-

SATELLITE DERIVED TECHNIQUE FOR ESTIMATING RAINFALL FROM THUNDER-STORMS AND HURRICANES,
National Environmental Satellite, Data, and Information Service, Washington, DC.
R. A. Scofield, and V. J. Oliver.
IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 70-76, 12 fig, 7 ref.

Descriptors: \*Meteorological data collection, \*Satellite technology, \*Rainfall intensity, \*Hydrologic data, \*Thunderstorms, \*Hurricanes, \*Data acquisition, \*Remote sensin, Rainfall rate, Rain gages, Rainfall distribution, Flooding, Forecasting.

The purpose of this paper is threefold: (1) to summarize the Scofield/Oliver technique for making marize the Scofield/Oliver technique for making rainfall estimates from convective systems, (2) to present the results using the technique in real time on major flash flood producing thunderstorms in Mississippi (April 1979) and on Hurricane Anita (September 1977) as the storm advanced into northeastern Mexico, and (3) to discuss some possible reasons why the technique often underestimates the copious rainfall associated with the slow moving remnants of tropical storms. The flash

flood producing thunderstorms occurred in Mississippi on April 11-13, 1979. Results showed that the 48-hour estimated heavy rainfall pattern was quite similar to the observed. As Hurricane Antita approached the coastal area, the San Antonio Weather Service Forecast Office (WSFO) was concerned with potential flooding in the Rio Grande basin and in Brownsville, Texas. During the critical time period from September 1-2, 1977, rainfall estimates were provided to the San Antonio WSFO. The results indicated that the rainfall estimates from Hurricane Anita were quite comparable with the ground truth rain gage measurements. (See also W87-09953) (Author's abstract)

UTILIZING GOES IMAGERY TO DETERMINE CONVECTIVE STORM CHARACTERISTICS IN DATA DEFICIENT REGIONS,

Jolly (J.P.) and Associates, Ottawa (Ontario).
J. P. Jolly.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
or Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 77-83, 5 fig, 2 tab, 2 ref.

Descriptors: \*GOES, \*Meteorological data collection, \*Hydrologic data, \*Satellite technology, \*Convective precipitation, \*Storms, \*Plicomayos River, \*Bolivia, \*Remote sensing, \*Data acquisition, Rainfall rates, Rainfall intensity, Clouds, Infrared imagery.

Recently hydrological modeling was required for a 13,000 square kilometer head water basin of the Pilcomayo River in southeastern Bolivia to find design flood flows for a proposed hydroelectric development. There are 18 daily precipitation gages in the basin, only two of which have contingages in the basin, only two of which have continuous recorders. This is insufficient to determine the basin hydrometeorological characteristics because of the predominance of small areal extent, high intensity thunderstorms in the region during the wet season. This hinders the determinations of the rainfall amounts as well as areal extents and basin response time. Using Geostationary Operational Environmental Satellite System (GOES) obtained enhanced infrared imagery and a recently devel-Environmentai sateinte system (GOES) outaineu enhanced infrared imagery and a recently devel-oped technique, which related heights and expan-sion/contraction characteristics of cumulonimbus clouds to one-half hour rainfall amounts, convective storms were analyzed. The relations betw cloud brightness levels on enhanced infrared imageries and one-half hour rainfall amounts were verified using regional recorded daily rainfall totals from which particular storms rainfall characteristics were estimated. This method has provided estimates of convective rainfall amounts in the continental United States. (See also W87-09953)

RAIN ESTIMATION OVER SEVERAL AREAS OF THE GLOBE USING SATELLITE IMAGE-

National Hurricane and Experimental Meteorology Lab., Coral Gables, FL. W. L. Woodley, C. G. Griffith, and J. A.

Augustine.

IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 84-91, 10 fig. 2 tab, 7 ref.
Bureau of Reclamation Contract No. 8-07-83-

Descriptors: \*Meteorolgoical data collection, \*Hydrological data, \*Remote sensing, \*Rainfall, \*Forecasting, \*Satellite technology, \*Imagery, Data acquisition, Computers, Flooding, Computer programs, Convective precipitation, Weather forecasting the secretary of the control of ing, Rain gages.

A computer-automated technique to estimate rainfall using digital, infrared geosynchronous satellite imagery has been developed and tested. The method requires time histories of convective entiities at discrete temperature thresholds and a set of empirical relationships. Development of tracking software and access to a large computer now permit rain estimates for large (> 1.0 times 10 to

the 7th power sq km) areas down to individual clouds. Rain estimates for several areas of the globe (Florida, the tropical Atlantic Ocean and western Africa, the eastern tropical Pacific Ocean western Arnoa, the eastern tropical Facilic Ocean and tropical South America, two flash flood situations, and the U.S. High Plains) are presented. There are many uses of the rain estimation method in its present form. The technique is ready for use in weather modification experiments to assess the potential extra-area effects of seeding. It is well potential extra-area effects of seeding. It is well suited to large area rain estimation especially if a small, dense network of rain gages is available for adjustment purposes. The method can also be used in climatological studies in programs such as EPOCS to investigate air-sea interactions as manifested by rainfall. It will be especially useful to study the El Nino phenomenon that occurs periodically off the northwest coast of South America, which results in recessive rains and the disruption which results in excessive rains and the disruption of the fishing industry. Rain estimates can be made on a continuing basis for river forecasting and flood warning. As indicated in the body of the flood warning. As indicated in the body of the paper, a somewhat modified version of the method is already in use in the U.S. for assessing the flood potential of tropical storms and hurricanes that are approaching land. Rain estimates might also be made over remote, poorly gaged drainage basins for the purposes of screening potential sites for hydroelectric facilities. Finally, agricultural uses might include day-to-day monitoring of precipitation over major crop-growing areas to identify areas of precipitation excess and deficiency and to project crop production. Once the real-time, iteraproject crop production. Once the real-time, iterative modification has been made, the technique can be used to monitor convective rainfall over vast areas for flash flood identification and warning. If necessary, warnings might then be issued by regional offices. (See also W87-09953) (Lantz-PTT)

SATELLITE RAINFALL ESTIMATION BY CLOUD INDEXING METHODS FOR DESERT LOCUST SURVEY AND CONTROL,

Bristol Univ. (England). Dept. of Geography

E. C. Barrett.

In: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 92-100, 5 fig, 28 ref.

Descriptors: \*Meteorological data collection, \*Hydrologic data, \*Satellite technology, \*Clouds, \*Desert locust, \*Rainfall, \*LANDSAT, \*Remote sensing, Forecasting, Meteorology, Infrared imagery, Weather forecasting, Mapping.

Cloud indexing techniques to improve rainfall assessment for climatological purposes have been developed by the author for application on short term bases and tested in various tropical and subtropical regions for use in several meteorological, agrometeorological, and hydrological projects. The cloud indexing approach has been most widely used in northwest Africa in connection with desert locust survey and control. This paper describes the method being used for this purpose, in the context of the prevalent practical and financial constraints. In this program polar orbiting satellite visible and infrared (VIS and IR) imagery are analyzed manually in conjunction with convenare analyzed manually in conjunction with conventional weather reports from Global Telecommuni cations System stations in Algeria, Libya, Moroc-co, and Tunisia in order that satellite and convenco, and Tunisia in order that satellite and conventional indications of rain might be integrated to provide better rainfall maps for 12 hourly intervals than could be prepared using either data source alone. The results are aggregated on a weekly and monthly basis. The monthly maps are used in the assessment of associated 'locust hazard' through their indications of areas of likely vegetation flush in the desert: they are used in the procurement of Landsat images for post rainfall vegetation mapping, and for the direction of ground inspection team survey routes. National personnel have been trained for the fully operational program, which is being implemented in a new remote sensing office in Algiers. (See also W87-09953) (Author's abstract) W87-09971

## Data Acquisition—Group 7B

ESTIMATION OF RAIN RATE OVER LAND FROM SPACEBORNE PASSIVE MICROWAVE

ental Research and Technology, Inc., Environme Concord, MA.
M. G. Fowler, H.-H. K. Burke, K. R. Hardy, and

Descriptors: \*Meteorological data collection, \*Rainfall rate, \*Satellite technology, \*Remote sensing, \*Microwaves, \*Hydrologic data, Precipitation, Rainfall distribution, Model studies.

The areal extent and variability of rainfall plays a key role in the availability and distribution of water resources and soil moisture amounts. In the past, it has been difficult to obtain widespread data on the spatial characteristics of rain, but techniques employing spaceborne microwave radiometers show great potential for future rain rate estimation. Detailed models of the scattering and absorption due to rain drops at microwave frequencies have been developed and show that the presence of rain causes a decrease in brightness temperatures relative to the background at frequencies greater than 30 GHz. The amount of this cooling increases with tive to the background at frequencies greater than 30 GHz. The amount of this cooling increases with increasing rate and varies with the physical characteristics of the rain and associated cloud layers. The effects of these variations have been analyzed and used in a climatological inversion technique with data from channels near 33 and 85 GHz to with data from channels near 35 and 85 GHz to show that rain rate can be reliably estimated for most rain and surface conditions and to identify situations where ambiguity in rain estimates may occur. (See also W87-09953) (Author's abstract) W87-09972

DETERMINATION OF RAINFALL RATES FROM MEASUREMENTS OF THE SATELLITE NIMBUS 5 AND 6,

LITE NIMBUS 5 AND 6, Cologne Univ. (Germany, F.R.). Inst. of Geophysics and Meteorology. H. J. Jung, and E. Raschke. IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 109-114, 7 fig, 17 ref.

Descriptors: \*Meteorological data collection, \*Hydrologic data, \*Rainfall rates, \*Satellite technology, \*Remote sensing, \*Data acquisition, Microwaves, Precipitation, Rainfall intensity, Mathematical studies, Model studies, Hydrometeorology.

ical studies, Model studies, Hydrometeorology.

Radiative transfer calculations in the microwave range (19.35 and 37 GHz) are performed to establish a quantitative relationship between the thermal emission at the top of the atmosphere and the precipitation intensity expressed in terms of rainfall rates. Models of precipitating clouds with variable geometrical and optical thickness are introduced assuming different drop size distributions for hydrometeors (cloud-, rain drops, ice and hail particles). Detailed studies of the radiative transfer for various rain cloud models and different emission and reflection properties of the ground indicate an accuracy of the rainfall rate derived from satellite measurements of 30-40% (0.1-7 mm/hr) and 5-100% (7-50 mm/hr). Additional information about the polarization of the emitted radiation and the cloud height inferred from infrared measurements is used for the determination of rainfall rates over hurricanes in the North Pacific Ocean. (See also W87-09973) (Author's abstract)

PRELIMINARY EVALUATION OF INITIAL ATMOSPHERIC MOISTURE FROM THE TIROS-N SOUNDING SYSTEM,

TIROS-N SOUNDING SYSTEM,
National Environmental Satellite, Data, and Information Service, Washington, DC.
A. Gruber, and C. D. Watkins.
IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 115-123, 9 fig, 4 tab, 2 ref.

Descriptors: \*Meteorological data collection, \*Hydrological data, \*Data interpretation, \*Evaluation, \*Atmospheric water, \*TIROS-N, \*Satellite technology, \*Remote sensing, Radiosondes, Precipita-

Results from a preliminary evaluation of the moisture sounding system of TIROS-N satellite data are presented. Comparisons were made to radiosondes over the central and eastern United States during April and September 1979. The satellite observations do not have enough vertical, thus providing a very smooth vertical profile. The total column precipitable water was however, reasonably well represented. Because of the smooth vertical profiles and the fact that moisture frequently found in the vertical, thus providing a very smooth vertical profile. The total column precipitable water was however, reasonably well represented. Because of the smooth vertical profiles and the fact that moisture retrievals are not obtained in cloudy areas the computation of the atmospheric water balance was judged to be impractical. (See also W87-09953) (Author's abstract) (Author's abstract) W87-09974

MODELING THE TERRESTRIAL HYDROLOGY FOR THE GLOBAL ATMOSPHERE: THE FUTURE ROLE OF SATELLITE DATA, Connecticut Univ., Storrs. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2A.
W87-09975

STATISTICAL APPROACH TO RAINFALL ESTIMATION USING SATELLITE DATA, National Environmental Satellite, Data, and Information Service, Washington, DC.
For primary bibliographic entry see Field 2B.
W87-09976

ROLES OF SATELLITES IN HYDROLOGY, Geological Survey, Reston, VA. D. G. Anderson.

D. U. Anderson. IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 144-155, 11 fig, 26 ref.

Descriptors: \*Remote sensing, \*Hydrological data, \*Satellite technology, \*Hydrologic data, \*Data acquisition, \*Ouachita River, \*Arkansas, \*Louisiana, \*Albemarle Sound, \*Pamlico Sound, \*North Carolina, Precipitation, Remote sensing, Infrared imagery, Microwaves, Electromagnetic waves, Precipitation.

Data from four satellite systems (Apollo, LAND-SAT, Nimbus, and Heat Capacity Mapping Mis-sion) are used to demonstrate hydrologic applica-tions concerning three areas (Arctic region; Oua-chita River, Arkansas-Louisiana; and Albemarle-Pamlico Sounds, North Carolina). These examples Pamlico Sounds, North Carolina). These examples were selected to encourage use of data from a wide range of spectral bands (visible, near infrared, thermal infrared, and microwave) and resolution (30 m to 50 km). Each image used provides a different look (spatial, spectral, or temporal) at the dynamics of water related phenomena. The conclusion is that data from satellites, if analyzed at the initial stages of a hydrologic study, can provide valuable conceptual information on the hydrologic systems involved. (See als. W87-09953) (Author's abstract) W87-09977

SATELLITE SNOW MAPPING TECHNIQUES WITH EMPHASIS ON THE USE OF LAND-

ental Research and Technology, Inc., Environm cord, MA.

Concord, MA.
C. J. Bowley, and J. C. Barnes.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 158-164, 7 fig, 18 ref.

Descriptors: \*Satellite technology, \*Snow, \*LANDSAT, \*Mapping, \*Remote sensing, Weather forecasting, Monitoring, Data acquisition, Forecasting.

The potential of the satellite for mapping snow cover was recognized soon after the launch of the first United States weather Satellite nearly 20 years first United States weather Satellite nearly 20 years ago. Since that time, as improved satellite systems have been developed, an increasing use has been made of remote sensing from space to monitor snow. Maps showing percentage of snow cover for selected river basins are now produced on a routine basis from the NOAA operational satellite imagery, and data from Landsat have been shown to have practical application for snow mapping. This paper reviews the types of satellite data that have been used to map snow cover and the interpretive techniques that have evolved. The emphasis in the review is on the application of Landsat data in the four ASVT (Applications Systems Verification and Transfer) Snow Project study areas, and the development of methods to use snow covant and the development of methods to use snow cov-ered area from Landsat in runoff prediction. The application of remote sensing in portions of the spectrum other than the visible is also discussed. (See also W87-09953) (Author's abstract) W87-09978 87-09978

APPLICATION OF SNOW COVERED AREA TO RUNOFF FORECASTING IN THE SIERRA NEVADA, CALIFORNIA, Sierra Hydrotech, Placerville, CA. For primary bibliographic entry see Field 2C. W87-09979

SATELLITE IMAGE ATLAS OF THE EARTH'S

SATELLITE INVASA.
GLACIERS,
Geological Survey, Reston, VA.
R. S. Williams, and J. G. Ferrigno.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
1081 p. 173-182, 5 fig, 25 ref. on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 173-182, 5 fig, 25 ref.

Descriptors: \*Satellite technology, \*Glaciers, \*Mapping, \*Maps, \*Remote sensing, \*Hydrologic data, LANDSAT, Glaciology, Antarctica, Greenland, Iceland, Monitoring, Ice.

Until the launch in 1972, 1975, and 1978 of the three satellites in the Landsat series of spacecraft, glaciologists had no accurate means of measuring the extent of glacier ice on Earth. Landsat images, where adequate coverage exists, provide a means for delineating the areal distribution of glaciers on a common data base for most of the Earth between about 82 degrees North and South latitudes. In June 1977, the Earth Resources Observation Sys-tems (EROS) Program of the Land Information and Analysis (LIA) Office of the U.S. Geological tems (EROS) Program of the Land Information and Analysis (LIA) Office of the U.S. Geological Survey (USGS) initiated an international project to prepare a USGS Professional Paper, Satellite Image Atlas of Glaciers. The project now includes the active involvement of 55 glaciologists and scientists in related disciplines from 30 U.S., foreign, and international organizations. The Atlas will cover both the geographic distribution of glaciers as well as topics of glaciology and related environmental phenomenon using Landsat, NOAA, and other satellite data. The primary objectives of the Atlas are: (1) to provide a pictorial inventory, either in the form of a satellite image or by tabular listings, of available images of the Earth's glacierized regions; and (2) to demonstrate the value of this imagery as a source of scientific data for the study and monitoring of some of the characteristics of glaciers, some aspects of the dynamics of glaciers, the response of glaciers to global climatic change, and as the basis for a series of 1:250,000-scale (multispectral scanner (MSS) images) Landsat image maps of those areas of the globe where glaciers exist. If Landsat-type surveys of the planet are continued for several decades then a means of monitoring long term changes in overall glacier extent will also become possible, thereby providing a method for monitoring the response of glaciers to climate change. (See also W87-09953) (Author's abstract) W87-09980 W87-09980

SATELLITE RECORD OF THE WINTER OF 1978-79 IN NORTH AMERICA, National Environmental Satellite, Data, and Information Service, Washington, DC.

### Group 7B-Data Acquisition

D. R. Wiesnet, and C. P. Berg.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing. Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 183-187, 10 fig, 1 tab, 10

Descriptors: \*Satellite technology, \*North America, \*Snow cover, \*Hydrologic data, \*Remote sensing, Snowpack, Monitoring, Seasonal varia-

A 13-year satellite record of monthly mean snow cover for North America has resulted from NOAA/NESS satellite monitoring of snow cover. The 1978-79 snow cover for December through March exceeded expected variability. December snow cover was the highest of record for any anow cover was the highest of record for any December; January snow cover was slightly below the record January 1978 snow cover, but was well above average; February snow cover was the second highest February of record; March snow cover was above average. In North America the past three winters have been severe and the snow cover figures reflect this severity. The trend has been toward increasing snow cover. In 1977, January snow cover exceeded one standard deviation; in 1978, both January and February acceeded on standard deviation; in 1979, December (1978), January, and February exceeded on standard deviation. Nevertheless, the severity of the 1978-79 North American Winter was judged to be a regional rather than a hemispheric or global be a regional rather than a hemispheric or global phenomenon. (See also W87-09953) (Author's ab-

POTENTIALS OF MAPPING BURIED GLA-CIER ICE WITH LANDSAT THERMAL IM-

AGERY, State Univ. of New York Coll. at Geneseo. Dept. of Geography.
For primary bibliographic entry see Field 2C.
W87-09982

PREDICTION OF WATER YIELD USING SAT-ELLITE IMAGERY AND A SNOWMELT SIMU-LATION MODEL,

Arizona Univ., Tucson. School of Renewable Nat-ural Resources.

W. O. Rasmussen, and P. F. Ffolliott.

W. O. Kasmusseri, and F. F. Folloldt.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 193-196, 1 fig, 14 ref.

Descriptors: \*Water yield, \*Satellite technology, \*Snowmelt, \*Model studies, \*Remote sensing, \*Hydrology, \*Forecasting, Simulation analysis, Computer models, MELT, YIELD, Land manage-

A prototypical computer simulation model which employs Landsat imagery has been developed to estimate the impacts of alternate land management activities on water yield in snow covered forests. activities on water yield in snow covered forests.

A degree-day snowmelt technique is used to predict daily melt, with daily streamflow being computed from recession analysis. The model, MELT, allows users at remote locations to readily obtain predictions of water yield with modest computer equipment and commonly available input data.
MELT is structured in an interactive format to MELT is structured in an interactive format to facilitate use by persons not familiar with computer operations. The model is written in ANSI Standard FORTRAN, requires 5000 words of core, and is operative on a DEC-10 computer at the University of Arizona. Although the prototypical version of MELT represents southwestern ponderosa pine forest ecosystems in central Arizona, the conceptual framework is applicable elsewhere. While MELT has been designed to operate alone, it was also structured to act as a subroutine within a water yield simulator. This additional model, called YIELD, is part of a family of computer models being developed to aid watershed management specialists and land use planners estimate impacts of alternate land management practices. The ECOSIM (Ecosystem Component Simulation Models) family is composed, in part, of three mod-Models) family is composed, in part, of three mod-ules: FLORA for estimating responses of forest

overstory, herbaceous understory, and organic material; FAUNA for evaluating animal habitats, carrying capacities, and population dynamics; and WATER for assessing stream flow yield, sedimentation, and water quality. MELT and YIELD are within the WATER module and interface with many of the other modules within ECOSIM. (See also W87-09953) (Lantz-PTT)

ICEBERG DETECTABILITY PROBLEMS
USING SAR AND SLAR SYSTEMS,
INTERA Environmental Consultants Ltd.,

INTERA Environmental Consultants Ltd.,
Ottawa (Ontario).
M. E. Kirby, and R. T. Lowry.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 200-212, 19 fig, 3 tab, 10

Descriptors: \*Icebergs, \*Remote sensing, \*Hydrology, \*SAR, \*SLAR, \*Satellite technology, Radar, Ice.

The application of synthetic aperture radar (SAR) and real aperture side-looking airborne radar (SLAR) systems for the identification of icebergs involves an understanding of the complicated interactions between the radar beams and the multi-faceted bergs. This paper summarizes the major problems that have been encountered in iceberg census research from selected portions of SLAR and SAR airborne experiments that were recently conducted. In a pack ice situation with the SAR data, depression angle did not seem to be a limiting factor for iceberg detection since very few of the ice features appeared to exhibit the same high levels of radar return or spatial characteristics as the bergs. However, at incidence angles of less than 20 degrees the ground resolution becomes poorer than the slant range resolution while the sea and sea ice could become brighter and thus make iceberg detection difficult. At shallow depression and sea ice could become brighter and thus make iceberg detection difficult. At shallow depression angles, small features such as ridges appeared as bright as large bergs in the SLAR imagery, making berg detection difficult. It was not possible to classify icebergs according to size and type from the SLAR imagery or the SAR L-band, while it was possible with the SAR X-band imagery. Since list possible with the SAR X-band imagery. Since space satellites, the airborne systems offer attractive simulation possibilities. These systems have been used here to address such topics as iceberg detectability in relation to resolution, depression angle, sea clutter, and iceberg size and type. (See angle, sea clutter, and iceberg size and type. (See also W87-09953) (Lantz-PTT) W87-09984

PASSIVE MICROWAVE SENSING OF SNOW CHARACTERISTICS OVER LAND,
National Aeronautics and Space Administration,
Greenbelt, MD. Goddard Space Flight Center.
A. T. C. Chang, D. K. Hall, J. L. Foster, A.
Rango, and J. C. Shiue.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 213-217, 6 fig, 1 tab, 11
ref.

Descriptors: \*Snow, \*Microwaves, \*Remote sensing, \*Hydrology, \*Satellite technology, Snow cover, Snowpack, Radiation, Spectral analysis.

Research involving the microwave characteristics of snow was undertaken in order to expand the information content currently available from remote sensing, namely the measurement of snow covered area. Microwave radiation emitted from measurement of snow surface should provide addimeasurement or show surrace should provide auditional information on the internal snowpack properties. The intensity of microwave radiation received is a function of the temperature, density, crystal size and free water content of the snow layers and is commonly referred to as the bright-ness temperature (T sub B). Measurements of T sub B were conducted by truck-mounted, airborne, and spaceborne systems with various radiometers ranging in wavelength from 0.8 cm to 21 cm. The T sub B of a short wavelength (0.8 cm) was found

to decrease more rapidly with increasing snow depth than compared with the T sub B of a longer wavelength (6 cm). More scattering of the shorter wavelength (6 cm). More scattering of the shorter wavelength radiation by the snow crystals results in lower T sub B. The longer wavelength (6 cm) penetrates through meters of dry snowpack and was useful for assessment of the underlying ground conditions. By using a multispectral approach, it may ultimately be possible to estimate snow volume and snowpack conditions, as well as the wetness condition and frozen status of the ground beneath the snow over large great and consequent. beneath the snow over large areas and consequently improve snow melt runoff predictions. (See also W87-09953) (Author's abstract) W87-09985

LANDSAT DERIVED SNOW COVER AS AN INPUT VARIABLE FOR SNOW MELT RUNOFF FORECASTING IN SOUTH CENTRAL COLORADO, Soil Conservation Service, Denver, CO. Snow

Soil Conservation Service, Denver, CO. Snow Survey Unit.
B. A. Shafer, C. F. Leaf, and J. K. Marron.
IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 218-224, 11 fig. 5 tab, 5

Descriptors: \*Hydrology, \*Satellite technology, \*Remote sensing, \*Snow cover, \*Snowmelt, \*Colorado, \*Forecasting, \*LANDSAT, Runoff, Snowpack, Simulation analysis, Model studies, Prediction, Statistical models, Regression analysis,

LANDSAT imagery for the period 1973-78 was LANDSAT imagery for the period 19/3-78 was used to calculate snow covered are on six drainages in South Central Colorado. Snow covered area was used as a predictor variable to forecast both short-term and seasonal snowmelt runoff volumes. The Leaf-Brink Subalpine Water Balance simulation model was adapted to use snow covered to the product of the control of the co area as an input parameter to predict residual volume runoff. Areal snow cover was also used in volume runoff. Areal snow cover was also used in a statistical model to forecast runoff and is compared to current water equivalent index methods of forecasting. Currently available LANDSAT imagery is of sufficiently quality and resolution for accurate snow mapping by photo interpretative means. Delay in image delivery, occurrent of cloud cover, and a nine-day interval between satellite coverage diminish to a significant extent the amount of reliance one can place in using snow cover as a forecast parameter. A statistical regression model relating snow cover to seasonal volume cover as a forecast parameter. A statistical regres-sion model relating snow cover to seasonal volume flow, and a computerized simulation model which provides short-term and seasonal forecasts using snow cover as an input variable indicate about a 10% reduction in average forecast error can be realized through use of satellite derived snow cover in forecast procedures. A significant draw-back to using snow covered area exclusively to make streamflow predictions is the lack of applica-bility prior to commencement of the main snowbility prior to commencement of the main snow-pack recession which normally occurs after May 1. Water management decisions frequently need to be made late in March and in April, necessitating streamflow forecasts before snowpack depletion gets well underway. (See also W87-09953) (Lantz-PTT) W87-09986

MONITORING SNOW WITH MICROWAVES,

MONITORING SNOW WITH MICKOWAVES, Kansas Univ/Center for Research, Inc., Lawrence. Remote Sensing Lab.
W. H. Stiles, and F. T. Ulaby.
IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 225-229, 8 fig, 4 ref. NASA Contract No. 5-23777.

Descriptors: \*Hydrology, \*Satellite technology, \*Monitoring, \*Snow, \*Microwaves, \*Colorado, \*Remote sensing, Radar, Radiometry, Water po-

The results of an experimental investigation of the radar backscatter and microwave emission from snow are presented. The data were acquired from

#### Data Acquisition—Group 7B

a truck-mounted platform at a test site in Colorado over a period of two months. The response of the backscattering coefficient alpha (o) and radiometric temperature T sub ap were examined as a function of snow wetness at several microwave frequencies. Strong sensitivity to wetness is observed, particularly at wavelengths shorter than 4 cm. By incrementally piling dry snow and making microwave measurements, the response of alpha (o) and T sub ap to snow depth, and hence water equivalent, were used to estimate the attenuation through snow. The most important conclusion of this investigation is that the scattering and emission behavior of snow vary drastically as a function of frequency between 1 GHz and 37 GHz, which suggests that multifrequency operation has the potential to provide estimates on several snow parameters, primarily wetness profile and water equivalent, simultaneously. (See also W87-09953) (Author's abstract) lent, simultaneo thor's abstract) W87-09987

OPERATIONAL USE OF SATELLITE DATA FOR SNOW INVENTORY AND RUNOFF

FORECAST,
Norges Vassdrags- og Elektrisitetsvesen, Oslo.
G. Ostrem, T. Andersen, and H. Odegaard.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 230-234, 7 fig. 1 tab, 8 ref.

Descriptors: \*Remote sensing, \*Hydrology, \*Satellite technology, \*Data acquisition, \*Runoff, \*Forecasting, \*Morway, Water potentials, Monitoring, Snowmelt, Prediction.

Scandinavia has a large water power potential. In particular the high mountain plateaus in southwestern Norway receive considerable amounts of precipitation. The short distances to tidewater in numerous fjords provide favorable natural conditions for water power production. Most of the high mountain watersheds are not forested so variations in snow cover can easily be monitored from satelmountain watersheds are not forested so variations in snow cover can easily be monitored from satelite data. During the main snowmelt period, May to July, it is a vital concern for proper management of the power plants to know the expected inflow into their reservoirs. A method has been developed to use NOAA and TIROS data to evaluate remaining snow and to predict the corresponding melt water volume in a number of Norwegian high mountain basins. The method can only be used in vegetation free or almost vegetation free high mountain basins, and only during the snowmelt period, i.e., after some 20% of the land-scape has become snow free. The relation between remaining snow cover (as expressed in percent or remaining snow cover (as expressed in percent or in square km) and the subsequent melt water inflow was determined from experience in various basins in southern Norway, but may be used also in other areas. (See also W87-09953) (Author's ab-

USE OF RADAR IMAGERY FOR SURFACE WATER INVESTIGATIONS,

Jet Propulsion Lab., Pasadena, CA. M. L. Bryan.

M. L. Bryan.
Ih: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 238-251, 15 fig, 28 ref. NASA Contract No. NAS7-100.

Descriptors: \*Radar, \*Surface water, \*Hydrology, \*Remote sensing, Data acquisition, \*Satellite technology, Monitoring, Rivers, Channel flow, Floods, Coastal waters, Data interpretation, Hydrology.

Water resources studies using radar data have been oriented primarily toward understanding specific and somewhat narrow portions of the hydrologic cycle, namely soil moisture and free water content of snow. However, other features within the transportation and storage aspects of the cycle are suitable for investigation and monitoring using radar data. These features include surface water area, river valleys and channel patterns, flooded terrain, and the identification of coast lines and coastal features. In each case, the basic interpreta-

tion techniques are similar to standard aerial photion techniques are similar to standard aerial photography interpretations. However, radar imagery is collected by an active ranging instrument operating in the microwave portion of the spectrum which dictates that interpretation methodology be adjusted accordingly. This paper is concerned with interpretation of water features using L-band (HH) imagery collected by aircraft and satellite (Seasat) systems. Examples of the imagery and their interpretations provide an initial point to discuss the ambiguities and difficulties in such studies. (See also W87-09989) (Author's abstract)

EXAMINATION OF FLUVIAL MORPHOLOG-ICAL CHARACTERISTICS OF WESTERN AMAZON STREAMS FROM APOLLO-SOYUZ PHOTOGRAPHS,
Texas Univ. at Austin. Dept. of Geological Sci-

For primary bibliographic entry see Field 2E. W87-09990

HYDROLOGIC LAND USE CLASSIFICATION USING LANDSAT.

USING LANDSAT, Hydrologic Engineering Center, Davis, CA. R. J. Cermak, A. Feldman, and R. P. Webb. IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979, 1981. p 262-269, 5 fig, 3 tab, 8 ref.

Descriptors: \*Remote sensing, \*Hydrology, \*Satellite technology, \*Land use, \*LANDSAT, \*Hydrologic models, Data interpretation, Classification, Watersheds, Simulation analysis, Model studies, Discharge.

ies, Discharge.

The Hydrologic Engineering Center's experience with land use classification from Landsat multispectral imagery is described. Land use is required for the estimation of the hydrologic model parameters. The land use classification procedure used, developed at the University of California, Davis, for the Corps of Engineers, is an unsupervised, noninteractive approach requiring no special image processing equipment. Watershed land use was determined from Landsat digital data, entered into a geographic data bank, and compared with a conventional land use classification. Hydrologic simulation model parameters were estimated from land use and other basin characteristics. Basêd on this experience, the following conclusions can be made: (1) At the grid cell level Landsat land use can be expected to be in error about 1/3 of the time; (2) By aggregating the land use over the entire watershed, Landsat's misclassification of land use reduces to 2-8% for the major land use categories; (3) Both of the above accuracy assessments must be qualified by noting that conventional land use, to which Landsat was compared, will sometimes have land use categories that are inconsistent with the Landsat land use categories. Also errors introduced during geometric correction and resampling will be interpreted as Landsat misclassification errors when comparing on a cell-by-cell basis; (4) The UCD Procedure works. It is a complete, selfqueced during geometric correction and resampling will be interpreted as Landsat misclassification errors when comparing on a cell-by-cell basis; (4) The UCD Procedure works. It is a complete, self-contained package of computer programs and manual operations that permit a user to identifying the use of expensive, interactive image processing equipment; (5) Evaluated in terms of the difference in discharge frequency curves, the Landsat-derived land use was found to be completely adequate. The number and type of land use categories derived from Landsat data were sufficient to be able to apply two standard hydrologic modeling techniques, Snyder's unit hydrograph with percent imperviousness and the SCS curve number and lag method; and (6) Landsat land use can be directly incorporated into a watershed's grid cell data bank, thus providing an automated environment for applying the Landsat classification in routine hydrologic investigations. (See also W87-09953) (Lantz-PTT)

LANDSAT DATA F
PERMIT MONITORING, FOR REGULATORY

Army Engineer Waterways Experiment Station,

Vicksburg, MS.
A. N. Williamson.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 270-277, 8 fig. 3 ref.

Descriptors: \*Hydrology, \*Remote sensing, \*LANDSAT, \*Monitoring, \*Water quality control, \*Waste disposal, Computer programs, Regulations, Permits, Satellite technology, Cost-benefit

The U.S. Army Corps of Engineers Regulatory Permit Program for activities in navigable waters or oceans was revised in July 1973 to reflect changes in the definition of the terms 'navigable waters,' fill material,' and 'dredged material,' and to refine the Regulatory Permit Program. The major impact of these revisions is the requirement for a Department of the Army permit for water disposal of dredged or fill material in virtually every natural and erificial waters body in the disposal of dredged or fill material in virtually every natural and artificial water body in the United States including 'wetland' areas, such as mudflats, marshes, swamps, bogs, and inland and coastal shallows contiguous to these waters, whether these areas are regularly or only periodically inundated by water. The immensity of the requirements imposed on the Corps of Engineers by these revisions dictated that a method must be found that would revoid a coast effective was to by these revisions dictated that a method must be found that would provide a cost-effective way to periodically detect, identify, locate, and monitor activities requiring permits. One candidate for this application was Landsat. The multispectral scanner on board the satellite could provide relatively inex-serving and repetitive outperse of large-years. on board the satellite could provide relatively inexpensive and repetitive coverage of large areas of terrain. The resulting data could be conveniently processed to extract specific types of information for display. However, serious questions concerning the cost of data processing and the limited resolution required answers. This paper presents the results of a feasibility study using Landsat digital data to obtain information required by the Regulatory Permit Program. Procedures developed for extracting and displaying information and the results of applying this procedure for study of time-dependent changes within a study area are discussed. (See also W87-09953) (Author's abstract) W87-09992

OPTICAL AND DIGITAL ANALYSES OF LANDSAT DATA DEPICTING HYDROGEOLO-GICAL FEATURES OF THE DARYACHEH-YENAMAK AREA, IRAN, Nova Scotia Land Survey Inst., Lawrencetown. M. S. Akhavi.

M. S. AKBAYI. IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 278-283, 3 fig, 1 tab, 13

Descriptors: \*LANDSAT, \*Data acquisition, \*Daryacheh-ye-Namak, \*Iran, \*Remote sensing, \*Hydrology, \*Salt flats, \*Playas, \*Surface water, \*Evapotranspiration, \*Satellite technology, Saline water, Economic aspects.

water, Economic aspects.

Daryacheh-ye-Namak encompasses a large evaporation basin, characterized by salt flats and a widely fluctuating salt water surface. It is the terminus for the rivers and intermittent streams draining the Tehran area and the heavily populated and industrialized sectors of northern Iran. Optical and digital processing techniques were used to detect and map hydrogeological and water resources features at the Daryacheh-ye-Namak (salt lake) area. The results of this investigation indicate that specialized image processing techniques are useful for depicting water to a variety of depths in this internal basin and for classifying various salt features of possible economic value. It was possible to estimate the volume of standing water to be in excess of 300 million cubic meters on May 25, 1976. It is apparent that all of the water discharging in Daryacheh-ye-Namak is first rendered unusable by the salt deposits, and then it is lost to evaporation. Hence, the amount of water reaching this evaporation basin presents an unused resource in the upper portions of the watershed where it is so critically needed. Therefore, additional utilization, diversion, and storage of the surface and

#### Group 7B-Data Acquisition

groundwater resources which would otherwise groundwater resources winter would otherwise reach Daryacheh-ye-Namak, could certainly be used for agricultural purposes and general economic improvement in the region. Existence of salt resources of possible economic value in the playa is another natural possibility for development that should be investigated and considered. (See also W87-09953) (Lantz-PTT)

IMPROVING STREAM FLOW ESTIMATES THROUGH THE USE OF LANDSAT,
Geological Survey, Madison, WI. Water Re-For primary bibliographic entry see Field 2E. W87-09994 sources Div.

FLOOD APPLICATIONS OF SATELLITE IM-AGERY,

eric Environment Service, Downsview (Ontario).

Kruus, M. Deutsch, P. L. Hansen, and H. L.

Perguson.
In: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 292-301, 12 fig, 1 tab, 7

Descriptors: \*Floods, \*Satellite technology, \*Hydrology, \*Remote sensing, Mapping, Monitoring, Flood forecasting, LANDSAT, Aerial photography, Hydrologic models, Snow cover, Snowmelt.

Remote sensing from satellites can be applied to floodplain mapping, monitoring of floods in progress, and the prediction of floods through observations of snowpack conditions. The paper illustrates various techniques that may be used to derive information relevant to floods from satellite imagery. Multistage sampling uses Landsat images and aerial photography at various scales to outline flood damage from a resignal scale to single fields. flood damage from a regional scale to single fields.
Multispectral composites may be made to enhance
features such as standing water or floodplain indicators for measurement or photointerpretation. cators for measurement or photointerpretation. Temporal composites are useful for comparing flood levels on various dates or, if one of the images shows the normal stage, for measuring flooded area. Digital mapping methods may also be used to detect, map, and measure the are covered by water at various stages for derivation of a stage storage curve. This information, together with the area covered by snow, as mapped from satellites, is useful as input to models for predicting runoff and assisting in flood control. (See also W87-0993) (Author's abstract)

NOTE ON INDIRECT DETECTION OF SEICHES IN GREAT SALT LAKE, UTAH BY NOAA AND LANDSAT SATELLITE IMAGERY, National Environmental Satellite, Data, and Information Service, Washington, DC. M. Matson, C. P. Berg, and D. R. Wiesnet

M. Matson, C. T. Derg, and D. K. Wiesinel. IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 303-307, 5 fig. 5 ref.

Descriptors: \*Seiches, \*Great Salt Lake, \*Utah, \*Satellite technology, \*LANDSAT, \*Remote sensing, \*Hydrology, Radiometry, Water currents,

On June 15, 1977, an unusual reflectance anomaly was detected in the north arm of Great Salt Lake, Utah, on NOAA-5 Very High Resolution Radioneter (VHRR) visible band imagery, and later on LANDSAT-2 multispectral visual band imagery. Comparison of north arm lake levels with meteorological parameters leads to the conclusion that the anomalous reflectance is associated with wind induced seiches in the north arm. Apparently, the wind induces anomalous current patterns and higher than usual current speeds and waves in the western part of the north arm; these currents and waves then entrain the fine grained sediments of the shallow lake bottom, thus increasing the turbid-ity and hence the reflectance of surface waters. (See also W87-09953) (Author's abstract)

W87-09996

ASSESSING THE RED RIVER OF THE NORTH 1978 FLOODING FROM NOAA SAT-

ELLITE DATA, National Environmental Satellite, Data, and Infor-

National Environmental Satellite, Data, and Information Service, Washington, D.C. C. P. Berg, D. R. Wiesnet, and M. Matson. III: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 309-315, 5 fig, 1 tab, 6 ref.

Descriptors: \*Remote sensing, \*Hydrology, \*Red River, \*Flooding, \*Satellite technology, Radiometry, Infrared imagery, Data acquisition, Data interpretation, Flood discharge.

Thermal infrared (IR) Very High Resolution Radiometery (VHRR) data from the polar-orbiting NOAA-5 satellite are used to map the spring 1978 flooding on the Red River of the North. The twice-daily VHRR-IR coverage provides the good flood extent mapping capability for small rivers having broad flood plains such as the Red River of the North (basin area 101,519 sq km). Flood extent is delineated with computer school and the red with the state of the North (basin area 101,519 sq km). is delineated using computer-enhanced, enlarged thermal IR images mapped onto 1:1,000,000 base maps and compared to ground-based hydrologic data. The resulting maps show the flood-inundated areas and the changes that occur as the flood proceeds downstream. (See also W87-09953) (Author's abstract)

PRELIMINARY ANALYSIS OF SAR MAPPING OF THE MANITOBA FLOOD, MAY 1979, INTERA Environmental Consultants Ltd.,

INTERA Environmental Ottawa (Ontario). For primary bibliographic entry see Field 7C. W87-09998

DELINEATION OF DRAINAGE AND PHYSIO-GRAPHIC FEATURES IN NORTH AND SOUTH DAKOTA USING NOAA-5 INFRARED

National Environmental Satellite, Data, and Information Service, Washington, DC. For primary bibliographic entry see Field 2E. W87-09999

SURVEY OF IN-SITU AND REMOTE SENSING METHODS FOR SOIL MOISTURE DETERMI-

National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. For primary bibliographic entry see Field 2G. W87-10000

CHARACTERISTICS OF MICROWAVE EMIS SION OF SIGNIFICANCE TO SATELLITE REMOTE SENSING OF SOIL WATER,
Texas A and M Univ., College Station. Remote

Sensing Center. R. W. Newton.

R. W. Newton.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 353-362, 18 fig, 18 ref.

Descriptors: \*Microwaves, \*Satellite technology, \*Soil water, \*Hydrology, \*Remote sensing, Model studies, Soil temperature, Wavelengths, Water

A technique for interpreting passive microwave emission measurements in terms of average soil moisture over a predicted soil depth was developed, while providing a limited set of experimental results that demonstrate an agreement with this development. In order to test the approach for a wider range of soil water and soil temperature profile shapes, an analytical model is used to pre-dict the microwaves emission at four frequencies of soil water and soil temperature profiles measured over a soil moisture range from saturation through dry down as well as at both day and night time periods. The average soil moisture and associated

depths were predicted from the microwave emisdepths were predicted from the microwave emission computations to determine if soil water and soil temperature profile shapes existed that caused ambiguous results, to determine if the effect of soil temperature could be compensated for, and to determine if there exists an optimum time of day for maximum depth of penetration. Within the constraints of the soil water and soil temperature profiles and microwave emission model utilized, it was determined that the auterne soil water reconstruction. files and microwave emission model utilized, it was determined that the average soil water parameter developed, and its associated depth, could be estimated from microwave emission measurements within a minimum of ambiguity. It was also demonstrated that the depth associated with the average soil water parameter is only slightly dependent on the soil temperature profile, indicating that an improvement in depth of penetration will probably not be obtained from night measurements. However, it was demonstrated that surface soil temperature could be used to normalize out the effects of ture could be used to normalize out the effects of soil temperature on the microwave emission. And, soft temperature of the incrowave emission. Am proved sensitivity to soil moisture due to the soil temperature profile shape. (See also W87-09953) (Author's abstract) W87-10001

POTENTIAL APPLICATION OF SATELLITE RADAR TO MONITOR SOIL MOISTURE,

Kansas Univ./Center for Research, Inc., Law-rence. Remote Sensing Lab.

rence. Kemote Sensing Lab.
F. T. Ulaby, G. A. Bradley, and M. C. Dobson.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 363-370, 11 fig, 1 tab, 29
ref. NASA Contract NAS9-14052.

Descriptors: \*Satellite technology, \*Soil water, \*Radar, \*Remote sensing, \*Hydrology, Monitoring, Microwaves, Data acquisition, Data interpre-

Realizing radar's high resolution capability, time-of-day independence and cloud cover penetrabiltity, a research program was conducted to evaluate the applicability of active microwave sensing for monitoring the spatial and temporal variation of soil moisture content. Calibrated truck mounted radars were used to measure the dependence of the scattering coefficient on the parameter of interest - soil moisture content - and on interference parameters - surface roughness and vegetation cover - so that the activities and the surface roughness and vegetation cover - so that the activities are surface roughness. that the scattering coefficient dependence can be minimized by properly choosing the sensor parameters (microwave frequency, angle of incidence range, and polarization configuration). This paper reviews the status of active microwave remote sensing research of soil moisture, based primarily on data acquired by the truck mounted systems.

The results obtained to date indicate that by operating at a frequency in the 4-5 GHz region over an angular range between 7 degrees and 17 degrees from nadir, the radar scattering coefficient is strongly correlated with soil moisture content and approximately independent of surface roughness and vegetation cover of agricultural crops. (See also W87-09953) (Author's abstract)

SOIL MOISTURE APPLICATIONS OF THE HEAT CAPACITY MAPPING MISSION,

South Dakota State Univ., Brookings. Remote For primary bibliographic entry see Field 7C. W87-10003 Sensing Inst.

REQUIREMENTS OF SPACE-BORNE MICRO-WAVE RADIOMETERS FOR DETECTING SOIL MOISTURE CONTENTS,

Environmental Research and Technology, Inc., Concord, MA.

H.-H. K. Burke, and W. J. Burke.

In-St. Bulke.

IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 377-383, 10 fig. 2 tab, 13 ref. NASA Contract Nos. NASS-25529 and NASS-

#### Data Acquisition—Group 7B

Descriptors: \*Satellite technology, \*Hydrology, \*Microwaves, \*Radiometry, \*Soil water, \*Remote sensing, Microwaves, Model studies, Measuring in-

There are two fairly independent problems to be solved in order to interpret signals measured by satellite microwave radiometers correctly: (1) the physical significance of the signals emitted by the surface and subsurface, and (2) the modification of that signal by the intervening atmosphere, a layered radiative transfer model is reviewed to study both aspects. Data from two NASA experiments utilizing L-band (21 km) and Ku band (1.67 cm) radiometers aboard aircraft taken near Phoenix, Arizona, in 1974 and 1975 with extensive simultaneous ground measurements, were studied in detail to assess the feasibility of monitoring the moisture content of agriculture soils from microwave radiometers aboard satellites. It is demonstrated that the near surface moisture can be determined quite accurately using the Ku band information. Fields with steep moisture gradients (for example, dry surface with wet subsurface), a combined Ku and L band measurements taken at different times of the field's drying cycle is required in order to determine the subsurface moisture content. An optimum sensor system of microwave radiometers for cell moisture detection in the different times of octernume the subsurface moisture content. An op-tionimum sensor system of microwave radiometers for soil moisture detection is then discussed in terms of the requirements for wavelength, polarization, time intervals between observations, and spatial resolu-tion. (See also W87-09953) (Author's abstract) W87-10004

CORRELATION OF GEOLOGIC STRUCTURE INFERRED FROM COMPUTER ENHANCED
LANDSAT IMAGERY WITH UNDERGROUND
WATER SUPPLIES IN ARIZONA,
Arizona Univ., Tucson. Office of Arid Lands Stud-

les.

R. Schowengerdt, E. M. Babcock, L. Ethridge, and C. E. Glass.

IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 387-397, 11 fig. 6 tab, 12 ref. OWRT Grant No. B-066-ARIZ, Contract No. 14.34,000.1860

Descriptors: \*Geohydrology, \*Groundwater potential, \*LANDSAT, \*Water supply, \*Hydrology, \*Structural geology, \*Satellite technology, \*Geology, \*Arizona, \*Remote sensing, Computers,

There is an increasing need in the Four Corners Region of the Southwest for dependable municipal and agricultural water supplies, in addition to the requirements of the rapidly expanding, coal fired power plants. It has been previously shown that well production in northern Arizona sandstone aquifers is enhanced by deep fracturing. If such fractures extend to the surface, corresponding fault patterns may provide a basis for exploration for additional water supplies. In this study, photolinements were mapped from standard EROS Data Center false color Landsat composites. In addition, hotolineaments were mapped using computer enhotolineaments were mapped using computer en Center false color Landsat composites. In addition, photolineaments were mapped using computer enhanced Landsat imagery of two intensive study sites. A third source of geologic structure data were existing large scale lineament density, was mathematically correlated with water well survey data (specific capacity, specific conductance, transmissivity, and water temperature) to establish the most useful combination of data for extension of lineament signatures' throughout the entire northeast quadrant. Results from this initial study indicate that Landsat imagery may be used to survey cate that Landsat imagery may be used to survey large areas for lineaments, and to cue the hydrogeologic to promising regions, which can then be mapped at aerial photography scales. (See also W87-09953) (Author's abstract)

LANDSAT DATA FOR LOCATING SHALLOW GLACIAL AQUIFERS IN EASTERN SOUTH

DAKOTA, South Dakota School of Mines and Technology, Rapid City. Dept. of Geology and Geological En-

gineering.
P. H. Rahn, and D. G. Moore.

IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 398-406, 8 fig. 11 ref.

Descriptors: \*LANDSAT, \*Data acquisition, \*Glacial aquifers, \*Hydrology, \*South Dakota, \*Satellite technology, \*Remote sensing, \*Mapping, \*Aquifers, Groundwater potential, Data interpretation, Model studies.

Described is an investigation to develop and evaluate procedures for mapping surficial glacial aquifers using LANDSAT imagery. The study region was the Prairie Coteau and adjacent areas in Eastern South Dakota, a relatively flat terrain consisting of ground and end moraines of various ages, and outwash and alluvial aquifers which generally underlie major river floodplains. Because of the majority of floodplains in this area were formerly glacial melt water channels, they are underlain by deposits of sand and gravel. Thus, the delineation of floodplains on Landsat imagery was the key to mapping potential aquifers. The temporal spectral information provided by LANDSAT varies throughout the crop growing season. An interpretation model based upon these spectral anomalies as associated with variations in cropping patterns correlated with hydrogeologic features was developed and applied. The model provides the interpretation key for using LANDSAT data. Aircraft and ground observations together with published many world Landset interpretation. In addition. pretation key for using LANDSAT data. Aircraft and ground observations together with published maps verify Landsat interpretations. In addition, for those phreatophytic crops, the shallow groundwater serves as a water source to maintain vigorous crop growth during the normally dry mid-and late-summer months. Because aquifers are associated with major floodplains, in many places they show broadly meandering or dendritic shapes. Landform analysis was aided by low sun angle, winter images to the snow covered landscape. (See also W87-09953) (Author's abstract) W87-10006

HYDROGEOLOGIC INTERPRETATIONS OF LANDSAT IMAGERY IN ARID ZONES OF SOUTH AND WEST AFRICA,

Bundesanstalt fuer Geowissenschaften und stoffe, Hanover (Germany, F.R.). For primary bibliographic entry see Field 7C. W87-10007

GROUND WATER EXPLORATION PRO-GRAMS IN AFRICA, Earth Satellite Corp., Chevy Chase, MD. For primary bibliographic entry see Field 2F. W87-10008

OBSERVATIONS ON LAKE ONTARIO BASIN HYDROGEOLOGY FROM OPTICAL EN-HANCEMENTS OF LANDSAT IMAGERY, Regional (Kenya).

A. Falconer, L. Myers, and M. Deutsch A. Falconer, L. Myers, and M. Deutsch. IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 427-436, 6 fig, 1 tab, 8 ref. USGS Contract Nos. 14-08-0001-13169 and 14-08-0001-3185, and NASA Contract No. NAS5-21783.

Descriptors: \*Lake Ontario, \*Geohydrology, \*LANDSAT, \*Infrared imagery, \*Groundwater potential, Photography, \*Hydrology, \*Remote sensing, \*Satellite technology, Data interpretation, Groundwater availability, Aquifers, Spectral anal-

Optical enhancements of Landsat data can provide low cost, synoptic views of the Lake Ontario basin suitable for hydrogeologic applications. Landsat data collected at different times provide both a record of seasonal change and data appropriate to specific needs. Geological structures in the Lake Ontario basin are most strikingly revealed when both sun angle and vegetation vigor are low. These features were further enhanced by a composite of October data from MSS bands 5,6, and 7. Basin-wide hydrogeological interpretations of potentially great value in groundwater exploration can be

based on optically enhanced, repetitive Landsat based on optically enhanced, repetitive Landaat data. By using a composite of July data from MSS bands 4.5, and 7, reprocessing of standard EDC products lead to the production of a low cost detailed, synoptic view of vegetation distribution and land use in the Lake Ontario basin. Some anomalies in vegetation distribution and density result from the presence of groundwater in shallow aquifers or groundwater discharge. More detailed processing using computer techniques can be un aquiters or groundwater discharge. More detailed processing using computer techniques can be undertaken on subscenes of particular interest on photo-optical enhancements or in areas of detailed hydrological studies. Reproduction of repetitive basinwide mosaics was easily achieved and is a low cost item that meets the demand for an operation. nyurological studies. Reproduction of repetitive basinwide mosaics was easily achieved and is a low cost item that meets the demand for an overview expressed by field scientists, managers, and politi-cal decisionmakers concerned with the Lake Ontario basin. (See also W87-09953) (Lantz-PTT) W87-10009

APPLICATIONS OF AEROSPACE DATA FOR DETECTION OF SUBMARINE SPRINGS IN

DETECTION OF SUBMARINE SPRINGS IN JAMAICA, Geological Survey, Woods Hole, MA. Water Resources Div. F. A. Kohout, D. R. Wiesnet, M. Deutsch, J. A. Shanton, and M. C. Kolipinski. IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 437-445, 7 fig, 8 ref.

Descriptors: \*Satellite technology, \*Jamaics, \*Groundwater potential, \*Springs, \*Hydrology, \*Submarine springs, \*Remote sensing, \*Geohydrology, Groundwater availability, Aquifers, Aerial photography, LANDSAT, Infrared imagery, Spectral analysis.

The sea very effectively masks submarine discharge and direct observations are difficult and expensive. The development of remote sensing instruments in recent years provides a powerful tool for detection of coastal submarine springs. Frequently, a turbidity plume is thrown up as fresh water mixed with sea water boils up from the sea floor, as at Mourant Bay. The submarine springs of the north coast of Jamaica discharge primarily clear water from cavernous karstic limestone. In contrast, the submarine springs of the south coast clear water from cavernous karstic limestone. In contrast, the submarine springs of the south coast appear to discharge from sand and gravel aquifers. Turbidity plumes that appear to correlate with linear geologic features are clearly visible in the aerial photographs of the Alligator Pond area. The existence of a submarine spring suggests that an aquifer may be underdeveloped and that wells might be drilled into permeable zones on the main-land to capture the water before it reaches the sea. In this regard, remote sensing of submarine springs In this regard, remote sensing of submarine springs can fulfill at least two useful functions: (1) the discovery of submarine discharge may help to discovery of submarine discharge may help to identify geologic or geomorphic structures on the mainland where there would be high probability of drilling successful wells, and (2) periodic observation of the thermal or turbidity anomalies associated with a submarine spring can serve as an outpost system for monitoring hydrologic changes brought about by future exploitation of the aquifer. The Landsat program of remote sensing by multispectral sensor, sun synchronous satellites may identify the nature of the changes, which now can only be inferred because of the sparse data presently available. (See also W87-09953) (Lantz-PTT)

GROUND WATER APPLICATIONS OF THE HEAT CAPACITY MAPPING MISSION, South Dakota State Univ., Brookings. Remote Sensing Inst. For primary bibliographic entry see Field 2F. W87-10011

LANDSAT CLASSIFICATION OF COASTAL WETLANDS IN TEXAS, Texas Univ. at Austin. Bureau of Economic Geol-

ogy.
R. J. Finley, S. McCulloch, and P. Harwood.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,

#### Group 7B-Data Acquisition

June 10-15, 1979. 1981. p 453-462, 10 fig, 3 tab, 15 ref. NASA Contract No. NAS5-20986.

Descriptors: \*LANDSAT, \*Coastal marshes, \*Wetlands, \*Texas, \*Mapping, \*Remote sensing, \*Hydrology, \*Satellite technology, Marshes, Classification, Data interpretation, Land use, Tidal

Through a multiagency investigation of LAND-SAT imagery applications, an analysis of Texas coastal wetlands shows that five Level III categories of wetlands can be delineated using image interpretation: topographically low marshes, topographically high marshes, tidal flats, see grass and algal flats, and vegetated dredged material. The categories contain a high level of information for the attestic turner law because of collections. caucagories comain a nign revei of information for the intrastate user, but because of climatic vari-ations these categories do not imply a coastwide assemblage of flora in each class. Marshes are spatially less uniform than on the southeastern spatially less uniform than on the southeastern coast of the United States, and species distribution varies within each category with local salinity differences. Image interpretation involves optical enlargement of 1:1,000,000 scale, Landsat transparenlargement of 1:1,000,000 Scale, Landsat transpar-encies to a scale of 1: 125,000 and mapping on a stable film base. Knowledge of coastal biologic assemblages allows the human interpreter to map on the basis of shape, texture, reflectance, and association of an area with respect to adjoining environmental units. Accuracies of 81 to 85% were environmental units. Accuracies of 81 to 85% were achieved for the marsh categories, 75% for the tidal flats, and 97% for sea grass and algal flats. Digital classification procedures, resulting in 124,000 scale line printer maps as output, require several iterations to display wetlands effectively. Accuracies of 65% were achieved for all wetland categories combined. Similarities in spectral radiance between grassland/rangeland and marshes, between mangrove wetlands and forest land, and between fallow field and muddy tidal flats result in some area misclassifications. However, advantages ne area misclassifications. However, advantages some area muscussincations. Flowever, advantages in this approach include consistency of results and compatibility with other digital data files. Present efforts aimed at developing an interactive digital image processing system and redesign of the classification system will probably offer a more effective metalon system will probably offer a more effective wetlands mapping capability as part of an overall land cover/land use mapping system. (See also W87-09953) (Author's abstract)

ACCURACY EVALUATION OF LANDSAT DIG-ITAL CLASSIFICATION OF VEGETATION IN THE GREAT DISMAL SWAMP,

Geological Survey, Suffolk, VA.
P. T. Gammon, W. G. Rohde, and V. Carter.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 463-473, 2 fig, 12 tab, 9

ref. ref

Descriptors: \*LANDSAT, \*Remote sensing, \*Wetlands, \*Satellite technology, \*Hydrology, \*Aquatic plants, \*Swamps, \*Great Dismal Swamp, \*Virginia, \*North Carolina, Classification, Spectral

A February 1974 and an April 1974 LANDSAT multispectral scanner (MSS) scene were geometrically corrected, registered, and resampled to provide a temporal composite for the Great Dismal Swamp of Virginia and North Carolina. The two scenes and the temporal composite were classified on the Interactive Digital Image Manipulation System (IDIMS) at the EROS Data Center, Sioux System (IDIMS) at the EROS Data Center, Sioux, Falls, South Dakota. Four classifications of the Landsat MSS data were made using: (1) all four bands of the February scene, (2) all four bands of the April scene; (3) bands 5 and 7 of the February and April scenes, and (4) all eight bands of the February and April scenes. The large number of spectral classes resulting from each classification were identified as to westation true and combined were identified as to vegetation type and combined at two levels of detail (Levels I and II) to obtain at two levels or detail (Levels I and II) to obtain eight final data sets. Level I categories were based on evergreen canopy species and understory type under deciduous canopy; level II vegetation cate-gories were based on canopy type. Classification accuracy of each data set was evaluated using a cluster sampling procedure to estimate the propor-

tion of picture elements correctly classified. Eight-two sample clusters of 100 pixels each were ran-domly selected, located on orrhophotoquds and photointerpreted on 1:65,000-scale color infrared photographs. At Level I, the majority of vegeta-tion categories had errors higher than 25%. At Level II, the grouping of deciduous canopy/un-derstory categories into one deciduous class gener-ally resulted in much lower errors. The evergreencategories at both levels provided varying accura-cy results. The errors on the whole were too high to be considered adequate for either mapping or management applications. (Author's abstract) W87-10013

USING LANDSAT MSS DATA WITH SOILS INFORMATION TO IDENTIFY WETLAND

INFORMATION TO IDENTIFY WETLAND HABITATS, Purdue Univ., Lafayette, IN. Dept. of Forestry and Natural Resources.

C. L. Ernst, and R. M. Hoffer.

IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 474-478, 6 fig, 2 tab, 6 ref. NASA Grant No. NGL 15-005-186.

Descriptors: \*LANDSAT, \*Wetlands, \*Spectral analysis, \*Ecosystems, \*Pigeon River, \*Hydrology, \*Satellite technology, \*Remote sensing, \*Indiana, \*Mapping, Data interpretation, Classification, Soil types, Algorithms.

A previous study showed that certain fresh water wetland vegetation types can be spectrally separat-ed when a maximum likelihood classification procd when a maximum interinous classification pro-cedure is applied to Landsat spectral data. Howev-er, wetland and upland types which have similar vegetative life forms (e.g., upland hardwoods and hardwood swamps) are often confused because of spectral similarity. Therefore, the current investi-gations attempts to differentiate similar wetland and upland types by combining Landsat multispec-tral scanner (MSS) data with soils information. The Pigeon River area in northern Indiana used in the earlier study was also employed in this investigation. A layered classification algorithm which combined soils and spectral data was used to generate a wetland classification. The results of the spectral/soils wetland classification are compared to the previous classification that had been based on spectral data alone. The results indicate wetland on spectral data atone. The results indicate weisand habitat mapping can be improved by combining soils and other ancillary data with Landsat spectral data. (Author's abstract) W87-10014

IMPROVEMENTS IN LAKE VOLUME PRE-DICTIONS USING LANDSAT DATA, National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. For primary bibliographic entry see Field 2H. W87-10015

LANDSAT HYDROBIOLOGICAL CLASSIFI-CATION FOR AN INLAND FRESH WATER MARSH WITHIN EVERGLADES NATIONAL PARK.

Everglades National Park, Homestead, FL. South Florida Research Center.
For primary bibliographic entry see Field 7C.
W87-10016

COMPARISON OF REMOTE SENSING TECH-NIQUES FOR MINNESOTA CLASSIFICATION, WETLANDS

Lockheed Electronics Co., Inc., Houston, TX.

Lockheed Electronics Co., Inc., Houston, TX.
L. F. Werth, and M. P. Meyer.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 492-498, 2 fig. 7 tab, 8 ref.
Univ. of Minnesota Agricultural Experiment Station Project No. MIN-42-037.

Descriptors: \*Minnesota, \*Wetlands, \*Remote sensing, \*Infrared imagery, \*Aerial photography, \*Satellite technology, \*LANDSAT, \*Data acquisition. Classification.

A wetland classification study in a typically com-plex 650 sq km test site in east central Minnesota compared the time, cost and accuracy of manually interpreted 1:24,000 scale color infrared aerial phointerpreted 1:24,000 scale color infrared aerial pho-tographs with digital analysis of Landsat data. The comparison was between the same general wetland and non-wetland classes, accuracy of both systems was evaluated with intensive ground verification. For the same general classes, the overall mapping accuracy was 96% for the aerial photo interpreta-tion and 71% for Landsat double-date classificaion and 71% for Landsat double-date classifica-tion. Results with maximum likelihood and SECHO classifiers were the same, 71%, while mapping accuracy with a layered classifier was only 66%. Compared to a general geometric cor-rection and a single-date data set, geographic posi-tion and classification accuracy improved when a precision geometric correction and a double-date data set were used. Landsat digital analysis was faster, 24 vs. 90 days, but photointerpretation was more economical at 30.15/hectare (including all costs of procurement, processing and analysis), compared with Landsat costs of \$0.35/hectare (not including costs of data procurement, processing prior to delivery to user and related overhead). (Author's abstract)

LANDSAT INTERPRETATION OF PRAIRIE LAKES AND WETLANDS OF EASTERN SOUTH DAKOTA, South Dakota State Univ., Brookings. Remote

For primary bibliographic entry see Field 7C. W87-10018

TECHNIQUE FOR IMPROVED ASSESSMENT OF FLOW RESISTANCE CHARACTERISTICS OF NATURAL WETLANDS USING LANDSAT

DATA, National Aeron

DATA,
National Aeronautics and Space Administration,
Greenbelt, MD. Goddard Space Flight Center.
J. C. Gervin, and S. F. Shih.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 507-511, 3 fig, 4 ref.

Descriptors: \*Flow resistance, \*LANDSAT, \*Wetlands, \*Data acquisition, \*Hydrology, \*Satellite technology, \*Remote sensing, Aquatic plants, Seasonal variation, Water depth, Marshes.

In the past, one value of the roughness coefficient has frequently been used to represent the flow resistance characteristics of an entire natural wetland throughout the year. To improve the simula-tion of water flow through these natural vegetation communities, Landsat imagery and in situ flow measurements could be combined to produce a more detailed representation of flow resistance.
The vegetation in a typical marshland drainage
basin in south Florida was classified into five major categories using Landsat data. Flow measurements were then performed at characteristic sites in the basin. The measurements were taken at various depths during months of significant flow to examine the effect of seasonal growth. This information can be combined with the areal extent of the vegetation measured by satellite to more accurate ly simulate resistance to water flow in natural marshland drainage basins. (Author's abstract) W87-10019

USING LANDSAT IMAGERY TO STUDY THE OKAVANGO SWAMP, BOTSWANA, S. M. Hutton, and T. Dincer.
IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 512-519, 5 fig, 3 tab, 20 ref.

Descriptors: \*Okavango Swamp, \*Botswana, \*Remote sensing, \*LANDSAT, \*Satellite technology, \*Hydrology, \*Swamps, \*Wetlands, Data acquisition, Hydrologic properties, Seasonal variation, Evapotranspiration.

Landsat imagery was used to calibrate a mathematical model of the area and flow distribution of the

### Data Acquisition—Group 7B

Okavango Swamp. By using the imagery to measure the area and observe the shape of the swamp and its subsystems, it was possible to estimate the depth and flow rates since these are correlated with the horizontal dimensions of the swamp. The imagery was also useful in assessing the relative importance of evaporation from surface water and transpiration from swamp vegetation. During winter, when water levels are high, evaporation is the dominant form of water loss, but in summer, losses are due equally to evaporation and transpirathe dominant form of water loss, but in summer, losses are due equally to evaporation and transpiration. Comparison of winter and summer imagery shows the bloom of vegetation and the recession of swamp waters during summer in contrast to the extent of surface water in winter. These observations support the findings of a stable isotope study of the swamp waters. The Okavango Swamp is an unstable system. The main direction of flow in the swamp has shifted dramatically over the last century. The extent of former swamp areas can be ry. The extent of former swamp areas can be identified and measured from Landsat imagery. (Author's abstract) W87-10020

COMPUTER-IMPLEMENTED REMOTE SENS-ING TECHNIQUES FOR MEASURING COAST-AL PRODUCTIVITY AND NUTRIENT TRANS-

National Aeronautics and Space Administration, NSTL Station, MS. Earth Resources Lab.

M. K. Butera.

IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 522-532, 3 fig. 3 tab, 21

Descriptors: \*Computers, \*Remote sensing, \*Coastal waters, \*Productivity, \*Hydrology, \*Satellite technology, \*Wetlands, \*Cycling nutrients, Nutrients, Computer programs, LANDSAT, Detritus, Marshes, Aquatic plants, Vegetation.

There are two important factors in evaluating the life-support function of a coastal zone. One is the vascular plant production of the marsh. The second is the effective transport of detritus and other nutrients, products of plant decomposition, to the estuary. An automatic technique has been developed to measure marsh plant production by inference from a species classification derived from Landsat MSS data. A separate computer technique has been developed to calculate the transport path length of detritus and nutrients from their point of origin in the marsh to the shoreline from Landsat data. A nutrient availability indicator, the ratio of production to transport path length, was derived production to transport path length, was derived for each marsh-identified Landsat cell. This invesfor each marsh-identified Landsat cell. This investigation supports the following findings: (1) Plant production levels for extensive areas of marsh can be determined from Landsat MSS data. Production is inferred from species. Thus, a classification of species association provides the basis for a 'map' of production values within the marsh; (2) The nutrient transport path length associated with the detritus exported from any locus in the marsh can be determined from Landsat MSS data. The measurement depends on a computer technique that calculates the distance between any point in the marsh and the nearest land/water interface using georeferenced Landsat data; and (3) The relative nutrient availability, a ratio of production to distance associated with each marsh locus, can be determined from Landsat MSS data. The use of a data base compatible with the Landsat format facilitates base compatible with the Landsat format facilitates the computation of nutrient availability. The nutrithe computation of nutrient availability. The nutri-ent availability indicator signifies the relative im-portance of any locus in the marsh to the life-support function of the coastal zone. (Lantz-PTT) W87-10021

MULTISFECTRAL KELP RESOURCE SUR-VEYS.

Georgia Univ., Athens. Dept. of Geography.

Georgia Univ., Attens. Dept. of Geography.
J. R. Jensen, J. E. Estes, and M. Mel.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 533-542, 8 fig, 3 tab, 23

Descriptors: \*Kelps, \*Multispectral analysis, \*Remote sensing, \*California, \*Hydrology, \*Infra-red imagery, \*LANDSAT, \*Satellite technology, Coastal waters, Data acquisition, Radar.

A multispectral approach to monitoring kelp resources is reported. Four dates of high-altitude color-infrared aerial photography (1:125,000), four dates of Landsat digital imagery, and two dates of X-band radar imagery were analyzed yielding kelp acreage estimates for beds along the Southern California Bight. These estimates were compared with statistics compiled by a private photogrammetric engineering firm responsible for monitoring Southern California beds. The practicality of monitoring kelp using these remote sensing systems is discussed. (Author's abstract)

REMOTE SENSING OF COASTAL POLLUT-ANTS USING MULTISPECTRAL DATA.

ANTS USING MULTISPECTRAL DATA,
Delaware Univ., Newark. Coll. of Marine Studies.
W. Philpot, and V. Klemas.
III: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 543-549, 7 fig. 2 tab, 6 ref.

Descriptors: "Remote sensing, "Coastal waters, "Path of pollutants, "Spectral analysis, "New York Bight, "Eigenvector analysis, "Satellite technology, "Hydrology, Data interpretation, Pollutant identification, Acid wastes, Wastewater disposal,

Sludge.

An attempt to use Landsat multispectral imagery for detection and classification of pollutants in coastal waters is described. The analysis technique applied to the Landsat data is the eigenvector (principal components) analysis, and was shown to be effective at distinguishing between pollutants (acid waste and sewage sludge) and clouds in the New York Bight. Semiautomated classification of a Landsat scene using a predetermined set of mean eigenvectors does not appear feasible at this time. It was demonstrated qualitatively that it is reasonable to relate higher intensity with higher concentration and that there is a systematic variability in the first eigenvector which may be related to a mean depth of the pollutant. Although the variability in the direction of the first eigenvector makes it more difficult to design a semiautomated classification technique, the fact that the variability is yestematic suggests that it may be possible to identify a target as a pollutant and to make some estimate of the concentration and mean depth of the pollutant. cemanus suggests that it may be possible to identify a target as a pollutant and to make some estimate of the concentration and mean depth of the pollutant. Eigenvector analysis should still be useful for this purpose although the criteria for classification would change somewhat. Furthermore, if the physical mechanisms suggested here (dispersion, settling) are indeed the controlling factors in the color variations in water, there is a reasonably good chance that this approach could be applied to inland waters as well as coastal waters. At present this would require the presence of one relatively deep, 'clear' water target within the Landsat scene in order to define the origin. With better understanding of the factors controlling apparent water color changes, it may eventually be possible to remove this restriction. (Lantz-PTT)

AEROSPACE REMOTE SENSING OF THE COASTAL ZONE FOR WATER QUALITY AND BIOTIC PRODUCTIVITY APPLICATIONS, National Aeronautics and Space Administration, Hampton, VA. Langley Research Center. E. B. Pritchard, and R. C. Harriss. IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 550-562, 11 fig, 3 tab, 25 ref.

Descriptors: "Remote sensing, "Coastal waters, \*Water quality, "Monitoring, "Hydrology, "Satel-lite technology, "Path of pollutants, Aerial photog-raphy, Productivity, Phytoplankton, Data interpre-tation, Spectral analysis, Fate of pollutants.

Remote sensing can provide the wide area synop-tic coverage of surface waters which is required

for studies of such phenomena as river plume mixing, phytoplankton dynamics, and pollutant transport and fate, but which is no obtainable be conventional oceanographic techniques. The com-bination of remote sensors, analytical/empirical algorithms for data analysis, and shipboard surveys provides a powerful tool for coastal zone research. The application of several remote sensors (aircraft-borne and spacecraftbourne multispectral scanners, positive and space-cattorume multispectras scanners, passive microwave radiometers, and active laser systems) to coastal zone research is discussed. Cur-rent measurement capabilities (particulates, chloro-phyll a, temperature, salinity, ocean dumped mate-rials, other pollutants, and surface winds and roughness) are defined and the results of recent roughness) are defined and the results of recent remote sensing experiments conducted in the North Atlantic coastal zone are presented. The future development of remote sensing must rely on an integrated laboratory research program in optical physics. Recent results indicate the potential for separation of particulates into subsets by remote sensors. Remote sensing can now make major contributions to specific coastal zone research problems. These include estuarine and continental shelf sediment transport dynamics, transport and fate of marine pollutants, marine phytoplankton dynamics, and ocean fronts. (Author's abstract)

DIGITAL ANALYSIS OF LANDSAT MSS DATA AND APPLICATION FOR COASTAL MARINE ENVIRONMENT,
Toba Merchant Marine Coll. (Japan). Dept. of

Oceanography.

H. Ochiai, and Y. Suzuki.

IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 563-569, 10 fig, 1 tab, 3

Descriptors: \*Coastal waters, \*Marine environment, "Satellite technology, "Hydrology, "LANDSAT, "Japan, Spectral analysis, Remote sensing, River effluent, Red tide, Water quality.

Techniques are presented for image analysis of remote sensing data obtained by Landsat in the study of marine environment applications in the coastal area of Japan. In the analysis of remote sensing data for a specific object, thematic analysis with feature extraction and classification techniques. with feature extraction and classification techniques for pattern recognition has become more popular. Using digital analysis, spectral characteristics of the data can be expressed quantitatively. Many flexible techniques can also be incorporated to find out the most effective method of analysis of remote sensing and field application. In an analysis of the marine environment, the classification per area is more effective than the classification per area is more effective than the classification per partial for relatively simple methods with a water of the property of pixel. For relatively simple methods with a wide variety of application, the authors have developed methods in which imagery is classified and ana-lyzed concerning the similarity of spectral data. The monitoring of marine environment is very important not only for Japan's fishing industry but also for the environmental administrative aspect. Therefore, the remote sensing by Landsat is expected to be one of the most conventional observa-tions of the marine environment in coastal areas. In nons or the marine environment in coastal areas. In this paper, the authors tried digital analysis of coastal phenomena such as river effluent and red tide, which is caused by abnormal growth of plankton influenced by polluted river effluent, and good results are obtained through this investiga-tion. (Author's abstract) W87-10025

SATELLITE OBSERVATIONS OF A GEO-THERMAL SUBMARINE SPRING OFF FLORI-DA WEST COAST, Geological Survey, Woods Hole, MA. Water Re-

sources Div. F. A. Kohout, R. C. Munson, R. M. Turner, and

N. R. Royal.

IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 570-578, 11 fig, 1 tab, 20

#### Group 7B-Data Acquisition

Descriptors: "Satellite technology, "Geothermal studies, "Submarine springs, "Hydrology, "Florida, "Springs, "Remote sensing, "LANDSAT, Groundwater, Water temperature, Aquifers, Turbidity, Infrared imagery.

A geothermal submarine spring location 19 km (12 miles) off the southwest shore of Florida has been miles) off the southwest shore of Florida has been recognized by thermal infrared and Landsat imagery. The location of the spring was roughly known from reports of fishermen. As part of research on remote sensing of hydrologic phenomena, an overflight was made by NASA aircraft equipped with a thermal infrared scanner in 1966. A sea surface thermal intrared scanner in 1966. A sea surface temperature anomaly was discovered suggesting that the upwelling groundwater was warmer than the ambient temperature of the surrounding sea water (about 68 F, 20 C). Ground trough investigation showed that the discharging groundwater had a temperature of 96.6 F (36 C) and the same salinity as normal sea water; it was emerging from a sink like depression about 200 ft (60 m) in diamea sink the depth of 63 ft (19 m) below sea level.

Anomalies have since been found on Landsat MSS bands 4, 5, and 6 that correlate with the fact that the spring ephemerally throws up a turbidity plume that spreads laterally over the sea surface as much as a kilometer in diameter. This apparently correlates with the name 'The Mud Hole' given to the spring by local fishermen. Turbidity plumes at three other locations in I and at imagery indicate three other locations in Landsat imagery indicate the upwelling phenomena is widespread and might be involved in triggering Red Tide plankton blooms that occur in this area. (Author's abstract) W87-10026

APPLICATIONS OF LANDSAT IMAGERY TO A COASTAL INLET STABILITY STUDY, Texas A and M Univ. at Galveston. Dept. of Maritime Systems Engineering.

Maritime Systems Engineering.
Y. H. Wang.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 579-584, 10 fig, 6 ref.

Descriptors: \*LANDSAT, \*Satellite technology, \*Coastal waters, \*Coastal engineering, \*Hydrology, \*Sandbars, \*Remote sensing, Mapping, Spectral analysis, Navigation canals.

The techniques of mapping the sandbars and their movements in the vicinity of a coastal inlet tradi-tionally a sounding boat and a survey team. The derived point and line information are then used to portouce the bottom contour map. Extensive inter-polations are needed because may details between the points and lines are missing. The operator is expensive and the procedures are time consuming. expensive and the procedures are time consuming. Techniques using remote sensing by satellite can be used to monitor the changes that take place, reducing cost and increasing efficiency. Previous studies have demonstrated that it is possible to correlate the radiance values of a multispectral imagery, such as Landsat imagery, with the depth related information. The present study is one more example of such an effort. Two sets of Landsat magnetic capes were obtained and displayed on the screen of tape were obtained and displayed on the screen of the Image-100 computer. Spectral analysis was performed to produce various signatures, their extent, and location. Subsequent ground truth obextent, and location. Subsequent ground truth ob-servations and messurements were gathered by means of hydrographic surveys and low altitude aerial photographs for interpretation and calibra-tion of the Landsat data. Finally, a coastal engi-neering assessment based on the Landsat dat was made. Recommendations regarding the navigation-al canal alignment and dredging practice are pre-sented in the light of inlet stability. (Author's abstract) W87-10027

COMBINED SATELLITE IMAGERY FOR STUDY OF COASTAL CIRCULATION, ONSLOW BAY, NORTH CAROLINA,

ONSLOW BAY, NORTH CAROLINA, C. W. Welby, and L. J. Pietrafesa. IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 585-592, 9 fig, 1 tab, 18 ref. DOE Contract No. EY-71-S-09-0902 and

Bureau of Land Management Contract No. 025-08.

Descriptors: \*Satellite technology, \*Coastal waters, \*Onslow Bay, \*North Carolina, \*Remote sensing, \*Hydrology, \*Raleigh Bay, \*LANDSAT, \*Water circulation, Water currents, Aerial photography, Seasonal variation.

A photo-optical technique using satellite imagery has been devised to study surface and near surface circulation patterns in the shallow shelf waters of Raleigh and Onslow bays, North Carolina. The NOAA-5 VHRR thermal imagery was matched photographically to the scale of the Landsat 70 mm transparencies, and the transparencies were superimposed in a color additive viewer, taking advantage of the scaling and rotational capabilities of the viewer. Various combinations of filters together with positive and negative transparencies were used to enhance the imagery for interpreta-tion. Through photographic enlargement and the projection capabilities of the viewer, imagery has been studied at scales between approximately 1:850,000 and 1:250,000. Combination of the image ry type enables the interpreter to differentiate be-tween cold and warm water masses, to interpret circulation patterns at the instant of imaging, and to identify the patterns of suspended matter distribution and dispersion in the shallow bays. With this information the interpreter can improve his understanding of the relative effects of varying forces on water mass movement. Moored current meter and temperature data collected in April and May 1978 contemporaneous with the acquisition of the satellite imagery serve as a check against imagery interpretation, and the imagery supports independent interpretations made from the current meter data. (Author's abstract) W87-10028

SATELLITE DETECTION OF OIL ON THE MARINE SURFACE,

National Aeronautics and Space Administration, Washington, DC. M. J. Wilson, P. E. O'Neill, and J. E. Estes

In: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 593-602, 9 fig, 14 ref.

Descriptors: \*Satellite technology, \*Oil pollution, \*Spectral analysis, \*Remote sensing, \*Marine environment, \*Hydrology, \*Path of pollutants, Pollutant identification, Oil slicks, LANDSAT, Radar, Infrared imagery.

The ability of two widely dissimilar spaceborne imaging sensors to detect surface oil accumulations in the marine environment has been evaluated using broadly different techniques. Digital Landsat multispectral scanner (MSS) data consisting of two visible and two near infrared channels has been reconsested for sphane, contract between research visible and two near infrared channels has been processed to enhance contrast between areas of known oil coverage and background clean surface water. These enhanced images have then been compared to surface verification data gathered by aerial reconnaissance during the October 15, 1975. Landsat overpass. A similar evaluation of oil slick imaging potential has been made for digitally enhanced Seasat-A synthetic aperture radar (SAR) data from July 18, 1979. Due to the premature failure of this satellite, however, no concurrent surface verification data were collected. As a substitute, oil slick configuration information has been stitute, oil slick configuration information has been generated for the comparison using meteorological and oceanographic data. The test site utilized in both studies was the extensive area of natural seepage located off Coal Oil Point, adjacent to the University of California, Santa Barbara. (Author's

USING ENHANCED LANDSAT IMAGES FOR CALIBRATING REAL TIME ESTUARINE WATER QUALITY MODELS, Louisiana State Univ., Baton Rouge. Div. of Engi-

neering Research.
J. M. Hill, and D. S. Graham.

IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota,

June 10-15, 1979. 1981. p 603-614, 10 fig, 20 ref. NOAA Grant No. 04-158-44046.

Descriptors: \*LANDSAT, \*Estuaries, \*Water quality, \*Model studies, \*Hydrology, \*Florida, \*Apalachicola Bay, \*Satellite technology, \*Remote sensing Mathematical models, Mathematical analysis, Tides, Water circulation.

A study of the effects of silvicultural activities and associated channelization upon the quality of the receiving waters of Apalachicola Bay in north Florida is utilizing Landsat images and data to verify real time estuarine water quality models. Management of estuarine water resources requires that accurate mathematical paradigms of circulation and quality be made in order to evaluate the effects of different alternative scenarios. For such paradigms to be predictive in estuaries, it has been demonstrated that they must be in so called 'real time' in which the timestep is much shorter than the tidal period. Verification of such models requires good synoptic data. These are usually impossible to acquire as the time required to traverse the estuary by boats results in measurements being taken over most of the tidal cycle, while continuous observations taken at fixed points provide inad-equate spatial resolution at practical staffing levels. Circulation patterns in several specially en CHCUBIUM PATTERS IN SEVERAL SPECIALLY enhanced Landsat images show good comparison to output of finite element two-dimensional (2-D) vertically averaged models of Apalachicola Bay, hence infor-mation can be applied to both calibrate and verify estuarine water quality models. (Author's abstract) W87-10303

APPLICATION OF LANDSAT AND COMPUT-ER TECHNOLOGY TO POTENTIAL WATER POLLUTION FROM SOIL EROSION,

National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. For primary bibliographic entry see Field 5B. W87-10031

BAY OF FUNDY VERIFICATION OF A SYSTEM FOR MULTIDATE LANDSAT MEAS-

SYSTEM FOR MULTIDATE LANDSAT MEAS-UREMENT OF SUSPENDED SEDIMENT, Virginia Inst. of Marine Science, Gloucester Point. J. C. Munday, T. T. Alfoldi, and C. L. Amos. IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 622-640, 16 fig, 5 tab, 39 ref. NASA Grant No. NGL 47-022-005.

Descriptors: \*Bay of Fundy, \*LANDSAT, \*Suspended sediment, \*Path of pollutants, \*Sediment transport, \*Silting, \*Satellite technology, \*Remote sensing, \*Sedimentation, \*Turbidity, \*Hydrology, Water quality, Spectral analysis, Mathematical analysis, Model studies.

A system for automated multidate Landsat CCT MSS measurement of suspended sediment concentration (s) has been implemented and verified on nine sets (108 points) of data from the Bay of Fundy, Canada. The system employs 'chromaticity analysis' to provide automatic pixel-by-pixel adjustments of atmospheric variations, permitting reference calibration data from one or several dates to espatially and temporally extrapolated to other regions and to other dates. Correlation between a Landsat 'chromaticity coefficient' and log sub eS ystem for automated multidate Landsat CCT landsat 'chromaticity coefficient' and log sub eS as r=0.965, which produced a mean standard error of prediction of 30% of S. For verification, each data set was used in turn as test data against the data set was used in turn as test data against the remainder as a calibration set: the average absolute error was 44% of S over the range 1 < S < 1000 mg/L. Effects of sediment type and size were negligible. The effect of solar angle was negligible except near the Brewster angle. The system can be used to measure chlorophyll (in the absence of atmospheric variations), Secchi disc depth, and turbidity. In a study related to the Fundy Tidal Power Project, S contour maps were used to initialize and calibrate a numerical model, and were also interpreted in order to define sediment transport. nize and cambrate a numerical model, and were also interpreted in order to define sediment transport paths and hydrodynamic flow. Results indicate that no significant sedimentation is expected from the proposed Fundy tidal barrage during its design lifetime. (Author's abstract) ASSESSMENT AND CLASSIFICATION OF SE-LECTED ILLINOIS LAKES THROUGH THE APPLICATION OF SPACE TECHNOLOGY,

Illinois State Environmental Protection Agency, Springfield. Div. of Water Pollution Control. D. J. Schaeffer, R. P. Clarke, D. F. Sefton, and D. H. P. Boland.

H. P. Boland.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 641-648, 3 fig, 5 tab, 8 ref.

Descriptors: \*Classification, \*Illinois, \*Lake classification, \*Hydrology, \*Satellite technology, \*Remote sensing, \*LANDSAT, Spectral analysis, Mathematical studies, Algorithms, Lakes, Water quality, Data interpretatio

Selected Illinois lakes were assessed and classified by: (1) applying a complete linkage clustering algo-rithm to Landsat MSS data and interpreting the clusters by comparing the spectral composition and uniqueness of each with water quality data, field evaluations, lake morphology, and watershed characteristics; and (2) using Landsat spectral ranks as independent variables for the development of multiple regression models to obtain estimates of multiple regression models to obtain estimates of trophic indicator parameters and multivariate trophic indicator parameters and multivariate trophic indicator parameters and multivariate trophic indices and, subsequently, lake trophic state rankings and groupings. Cluster analysis of the raw spectral dat established distinctive lake groups, each comprised of water bodies having similar optical and physical properties. The spectral properties of each lake provided an integrated characterization of water quality and related use impairment problems. The trophic parameter esti-mates, as well as lake clusters and rankings derived from them, were in general agreement with contact-sensed data and with the raw spectral data. (Author's abstract) W87-10033

THERMAL PATTERNS OF LAKE MICHIGAN AND LAKE SUPERIOR FROM SATELLITE REMOTE SENSORS AND ITS USES,

National Weather Service Forecast Office, Rosement, IL.

H. W. Hoffman

III. Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 650-653, 3 fig. 1 tab.

Descriptors: \*Water temperature, \*Lake Michigan, \*Lake Superior, \*Satellite technology, \*Hydrology, \*Remote sensing, \*Thermal stratification.

Average surface water temperature maps were drawn for each month except for three months during the winter (due to ice). The data used were drawn for each month except for three months during the winter (due to ice). The data used were generated over a two-year period from the VHRR on NOAA-4 and -5 satellites. The purpose was to draw average surface water temperature maps for both Lake Michigan and Lake Superior in an attempt to gain understanding of short and long range thermal patterns. Upwelling, warm and cool areas, currents, and eddies were found in both lakes. Upwellings and eddies could be observed because of the abrupt change in temperature which may be due to wind/wave action, instability of the thermocline, 'lake overturn,' and/or lake bottom topography. Because of the changes in water temperature, near shore land mass climates are often different. Real time water temperatures observed in satellite can provide a base for gaining knowledge of water temperature patterns in lakes. This knowledge can also be used in forecasting lake algae blooms and growth, effluent buildups and reactions, and surface current movements. Meteorologists might be able to better forecast local near the state of the contractions of the contraction of ologists might be able to better forecast local near orogasis migat be able to better forecast local near shore precipitation, temperature, wind speed and direction, fog, and boating and recreation abilities. Forecasting temperatures of surface water may also be important in harnessing the oceans and lakes for energy needs, food production, and studying eutrophic processes. (Author's abstract) W87-10034

LAKE ONTARIO DYNAMICS AND WATER QUALITY OBSERVATIONS USING THEMATICALLY ENHANCED LANDSAT DATA, (Kenya).

(Renya).

A. Falconer, M. Deutsch, and L. Myers.

IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. p 655-661, 6 fig. 15 ref.

USGIS Contract Nos. 14-08-0001-13169 and 14-08-

Descriptors: \*Lake Ontario, \*Water quality, \*LANDSAT, \*Hydrology, \*Satellite technology, Sedimentation, Lake sediments, Turbidity, Infrared imagery, Aerial photography, Spectral analysis.

A Landsat image of western Lake Ontario was specially processed to enhance the detail of water phenomena significant for water quality and lake dynamics studies. The position, extent, and circulation pattern of the gyre of the Niagara River in Lake Ontario were clearly evident on the enhanced image. This thematic (water detail) enhancement also showed the pattern of sediment discharging from the Welland Canal, which appeared as a greater source of natural and man made pollution than the Niagara River itself at the time of imaging. Other turbidity patterns visible on the image indicate the surface and near surface dynamics of the lake. The infrared response of a large image indicate the surface and near surface dynamics of the lake. The infrared response of a large area in the west-central part of the lake suggested a concentration of chlorophyll bearing phytoplankton. A pattern of regularly spaced lines on the surface of the water in this area probably represents internal waves indicative of the dynamics of the water body. The versatility of Landsat data is demonstrated by the enhancement of data in multispectral scanner bands 4, 5, and 6 by photographic contrast stretching and thematic spectral compositing. The resulting enhancement was the basis for more detailed study of selected subscenes on a multispectral digital analysis system. Reprocessing. more detailed study of selected subscenes on a multispectral digital analysis system. Reprocessing, or photo-optical processing, of Landsat data in order to enhance water detail is a simple low cost technique that can be applied to the data in all spectral bands. Maximizing the use of a multisequent machine processing. For many purposes, there is no advantage in processing beyond optical reprocessing. (Author's abstract) W87-10035

APPLICATION OF DIGITAL IMAGE PROCESSING TECHNIQUES AND INFORMATION SYSTEMS TO WATER QUALITY MONITOR-ING OF LAKE TAHOE,
Jet Propulsion Lab., Pasadena, CA.
A. Y. Smith, and R. J. Blackwell.
IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 662-672, 7 fig, 8 ref.

Descriptors: \*Digital computers, \*Lake Tahoe, \*Water quality, \*Monitoring, \*LANDSAT, \*Satellite technology, \*Digital image processing, \*Remote sensing, \*Hydrology, Water quality control, Computer programs, Surface runoff, Drain-

age.

Lake Tahoe is one of very few natural lakes in the United States which has remained relatively undamaged by the encroaching developments of man. The management of Tahoe's water quality has become a subject of intensive study in recent years in an effort to define and limit the effects of nonpoint source pollutants that are input from the contributing drainage basins. As an aid to the water quality management effort, the Image Processing Laboratory at Caltech's Jet Propulsion Laboratory has interfaced Landsat data with topographic digital imagery from the Defense Mapping Agency, conventional maps, and tabular data to create a comprehensive information data base for Lake Tahoe and its er. irons. The project used the resources of the JPL developed IBIS programs to augment data gathered by the U.S. Forest Service and Department of Agriculture for the Tahoe Regional Planning Agency. The IBIS dat base method allowed cross correlation of Landsat imagery and topographic data with a variety of envi-

ronmental parameters relating to such indicators as surface runoff, drainage basin acreage, and terrain configuration. Parameters were evaluated and compared for each drainage basin defined by the Tahoe Regional Planning Agency (1977). The methods used to construct and update the information data base are described and evaluated. In addition, the utility of including Landsat imagery is discussed. (Author's abstract) W87-10036

TROPHIC STATE DETERMINATION FOR SHALLOW COASTAL LAKES FROM LAND-SAT IMAGERY, North Carolina State Univ. at Raleigh. Dept. of

W. Welby, A. M. Witherspoon, and R. E.

Holman.

IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 674-680, 6 fig, 3 tab, 20 ref. NASA Contract No. NAS8-31984.

criptors: \*Satellite technology, \*LANDSAT, "Coastal waters, "Lakes, "Remote sensing, "Hydrology, "North Carolina, Trophic level, Monitoring, Water quality, Aerial photography, Spectral

Conjunctive study of four shallow coastal plain lakes in northeastern North Carolina and their Landsat-2 images demonstrated the feasibility of differentiating between the lakes and determining their respective trophic states on the basis of Landsat multispectral scanner imagery. The investigation established that monitoring of the trophic states of the lakes on a seasonal basis through states of the lakes on a seasonal basis through states of the lastes on a seasonal basis through application of color-additive imagery enhancement techniques is possible. Utilizing a standard setting of the color-additive viewer, the 70 mm negatives of the imagery, and a numerical scale representing the various trophic states, the investigator can pre-pare standard curves for comparison. An internal pare standard curves for comparison. An internal standard of essentially constant reflectance charac-teristics forms the key to the comparison of the data from different images. Through comparison of the false-color renditions in the viewer screen with a standard interference color chart in combin a standard interrence color chart in combination with brightness measurements made directly from the viewer screen the investigator can relate the lake reflectances to their trophic states. Two or more bands of the imagery are required; the present study has established that for the lakes studied, Band 5 and Band 6 form a suitable combination. The technique is relatively interprensive and nation. The technique is relatively inexpensive and can be used by State and local agencies with minimal expense. (Author's abstract)

APPLICATION OF REMOTE SENSING FOR CALIFORNIA IRRIGATED LANDS ASSESS-

MENT, California Univ., Santa Barbara. Santa Barbara Remote Sensing Unit. L. Tinney, S. Wall, R. Colwell, and J. Estes. IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 689-693, 2 fig. NASA Grant No. NSG 2208.

Descriptors: \*Remote sensing, \*California, \*Irrigable land, \*Satellite technology, \*Hydrology, \*LANDSAT. Aerial photography, Agriculture, Irrigation districts, Irrigation design, Management

The 'Irrigated Lands Assessment for Water Management Ap; lications Pilot Test' is designed to develop and demonstrate remote sensing methodologies for the California Department of Water Resources. The project is a five-year cooperative effort involving the National Aeronautics and Space Administration (NASA), the California Department of Water Resources (DWR), and the University of California remote sensing programs at Berkeley and Santa Barbara. The present emphasis of the project is on a multistage sampling approach using Landsat imagery, aerial photography, and field verified data to inventory California.

#### Group 78—Data Acquisition

nia's approximately ten million acres of irrigated nia's approximately ten million acres of irrigated cropland. Agriculture accounts for approximately 85% of the State's water usage. DWR presently inventories agricultural land use for the entire state using low altitude aerial photography and field verification. Detailed land use maps are created at a scale of 1:24,000 using USGS 7-1/2 minute quadrangle topographic maps as a base. Manpower and budgetary constraints limit the frequency and acope of the map updating program to approximately 1/7th of the State per year. In addition to the irrigated cropland inventory tasks, both manual the irrigated cropland inventory tasks, both manual and digital techniques are being investigated in several test sites throughout the State for identifyseveral test sites throughout the State for identifying specific crop types or conditions. Several crops
(e.g., rice, small grains, and safflower) and cropping practices (e.g., multiple cropping and salinity
leaching) are of special interest to DWR because
of the importance of the crop and/or the difficulty
in its identification using present procedures. (Lantz-PTT) W87-10038

MULTISTAGE MAPPING APPROACH FOR AN IRRIGATED CROPLANDS INVENTORY, California Univ., Santa Barbara. Santa Barbara Remote Sensing Unit. L. Timey, J. Holloway, J. Baggett, and J. Estes. IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sious Falls, South Dakota, June 10-15, 1979. 1981. p 694-696, 2 fig.

Descriptors: \*Mapping, \*Irrigable land, \*Irrigation practices, \*Satellite technology, \*LANDSAT, \*Remote sensing, \*Hydrology, \*Cropland, \*Kern County, \*California, Agriculture, Aerial photography, Cost-benefit analysis

Since 1972, yearly maps of irrigated cropland have been supplied to Kern County Water Agency based on manual interpretation of satellite imagery or aerial photography. More recently a multistage mapping procedure has been implemented to effec-tively integrate both types of data. This combined tively integrate both types of data. This combined satellite and aircraft approach takes advantage of both the temporal frequency of Landsat multispectral imagery and the higher spatial resolution of aircraft photography to provide a product more useful than is available from either source individually. Multidate Landsat imagery is necessary for accurate mapping of irrigated cropland because of Kern County's long growing season, its wide variety of crops, and double cropping practices. While aircraft photography is obtained much less frequently than Landsat imagery, its higher spatial resolution is more suitable for detailed mapping of featurers such as field boundaries and homesteads, resolution is more suitable for detailed mapping of features such as field boundaries and homesteads, and identifying specific crop conditions. This detailed information has proven to be complementary to the temporal Landsat imagery in the classification process. A comparison with California Department of Water Resources field based maps for approximately 175,000 acres (five 7-1/2 minute USGS quadrangles) has shown the multistage approach to a very societies. proach to be very accurate. Only young permanent crops such as orchards and vineyards are difficult to identify. Because permanent crops are relatively stable once established, this problem appears amenable to improvements in interpretation procedures. Future improvements will allow for identification and mapping of permanent crops without yearly reinterpretations. The one month effort that will be required to complete each year's map will constitute a cost effective and operationally feasiconstitute a cost effective and operationally feasi-ble application of remote sensing technology for water management. Future research activities in-clude an evaluation of higher resolution Landsat Return Beam Vidicon imagery as a partial replace-ment for the aircraft photography and digital proc-essing of the multistage data. (Lantz-PTT) W87-10039

REMOTE SENSING OF BANK EROSION ALONG THE MISSOURI RIVER, SOUTH

DAKOTA, South Dakota School of Mines and Technology, Rapid City. Dept. of Geology and Geological Engineering. P. H. Rahn

IN: Satellite Hydrology. Proceedings of the Fifth

Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 697-700, 3 fig, 3 ref.

Descriptors: "Remote sensing, "Missouri River, "South Dakota, "Bank erosion, "Hydrology, "Satellite technology, "Erosion, "LANDSAT, Aerial photography, Stream erosion, Gavins Point Dam.

Aerial photographs and satellite imagery were used to determine areas of bank erosion along the Missouri River. A 55 mile (88 km) reach below Gavins Point Dam, South Dakota, was chosen for study because erosion is accelerated below Gavins study occause erosion is accelerated orion Oravins Point Dam, and there are no man-made structures such as rock walls to impede the erosional process. In order to use remote sensing to quantitatively determine the amount of bank erosion, it is necesdetermine the amount of bank erosion, it is neces-sary to have images of a given reach taken during different years. Ideally the discharge should be nearly the same when the images are taken, other-wise the contact between land and water simply reflects a different river stage. Cloud-free Landsat images when near-equal discharge conditions pre-vail were obtained in 1973 and 1976. In the 55 mile (88 km) reach studied, an estimated total erosion of 2,200 acres (890 hectares) and total accretion of 2,000 acres (810 hectares) occurred. The eroded 2,000 acres (810 nectares) occurred. In e eroded land is largely valuable cropland whereas the new land is almost entirely channel sandbars, marsh areas, and low islands having little economic value. Unlike the normal erosional pattern of a natural river, the Missouri River below Gavins Point Dam erodes both inner and outer sides of its meanders as well as along both sides of crossings between me-anders. This unusual pattern is attributed to the fact that the water discharging from the dam is sediment-free, and hence the stream equilibrium has been changed. (Author's abstract) W87-10040

SELECTED IRRIGATION ACREAGE ESTI-MATES IN NORTHERN FLORIDA FROM LANDSAT DATA, Suwanne River Water Management District,

White Springs, FL.
K. B. Webster, J. R. Lucas, R. J. Musgrove, and

K. B. Webster, J. R. Lucas, R. J. musgrove, and A. L. Higer. IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 701-705, 2 fig, 1 tab, 2 ref.

Descriptors: \*Irrigable land, \*Florida, \*LAND-SAT, \*Suwannee River, \*Remote sensing, \*Hydrology, \*Satellite technology, River basins, Irrigation water, Croplands, Corn, Rye, Irrigation.

The largest single use of water in the Suwannee River Water Management District (SRWMD) is for irrigation. Field inventories used to collect irrigation data are expensive and time consuming. Landsat image analysis was selected as a potentially economical method to collect irrigation data. A church was initiated to investigate and evaluate ly economical method to collect irrigation data. A study was initiated to investigate and evaluate Landsat data for identification of selected irrigated crop acreages. Two representative study areas, which typify cultivation and irrigation practices within the District, were chosen to test Landsat analysis techniques. Both test sites were located in Suwannee County, Florida. Based on a crop calendar developed by the SRWMD, optimal Landsat data were selected to determine the feasibility of identifying two irrigated crops. corn and reidentifying two irrigated crops, corn and rye, through manual and digital Landsat analysis tech-niques. (Author's abstract) W87-10041

MAPPING IRRIGATED LANDS IN WESTERN KANSAS FROM LANDSAT, Kansas Applied Remote Sensing Program, Law-

rence.
T. H. L. Williams, and J. Poracsky.
IN: Satellite Hydrology. Proceedings of the Fifth
Annual William T. Pecora Memorial Symposium
on Remote Sensing, Sioux Falls, South Dakota,
June 10-15, 1979. 1981. P 707-714, 6 fig. 3 tab, 19
ref. NASA Grant No. NGL 17-004-024.

Descriptors: \*Irrigable land, \*Kansas, \*LAND-SAT, \*Mapping, \*Ogallala Aquifer, \*Hydrology,

\*Remote sensing, \*Satellite technology, Irrigation water, Agriculture, Groundwater, Aquifers, Groundwater irrigation.

Groundwater irrigation.

In recent years the area of agricultural land under irrigation in Western Kansas has been increasing in response to socioeconomic factors and developments in irrigation technology. The irrigation water is primarily drawn from the Ogallala aquifer, a groundwater reserve that has a low recharge rate. The resulting drawdown in the water table has in some instances exceeded 100 feet, with current depletion rates averaging over five ft/yr in several areas. In order to predict current and future demands on the groundwater reserves, timely information is required on the extent and type of irrigated lands in the area. Based on previous research and a survey of crop calendars, a multidate visual interpretation technique using Band 5 Landsat imagery was developed to produce maps of irrigated lands in six western Kansas counties. Data from the maps was coded by quarter sections and input to a computer file for extraction fo statistics and production of line printer maps. Accuracy statistics derived from a detailed study of Finney County indicated a mapping accuracy of 85-99% (depending on the particular crop) and an aggregated areal statistics accuracy of 99% for the three major crops: wheat, corn, and sorghum. (Author's abstract) W87-10042

MAPPING IRRIGATED CROPLAND ON THE HIGH PLAINS USING LANDSAT.

Geological Survey, Reston, VA.
G. P. Thelin, T. L. Johnson, and R. A. Johnson G. P. Inelin, 1. L. Johnson, and R. A. Johnson. IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing. Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 715-721, 6 fig. 2 tab, 4 ref.

Descriptors: \*LANDSAT, \*Irrigable land, \*Mapping, \*Phillips County, \*Yuma County, \*Hydrology, \*Colorado, \*Satellite technology, Remote sensing, Groundwater irrigation, Data interpretation, High Plains Aquifers, Irrigation water.

The need to monitor the use of natural resources on a regional scale is increasingly apparent. Within the U.S. Geological Survey, a cooperative effort between the Water Resources Division and the National Mapping Division will provide maps of irrigated cropland for the High Plains aquifer that will serve as input to a computer model of the High Plains aquifer. Phillips and Yuma Counties, Colorado, have been designated as a study area for the development and testing of the methodology. Irrigated cropland of the study area was mapped three ways for the 1978 growing season: using classified source materials, by visual interpretation of I andsat imagery. and by computer-aided analy-The need to monitor the use of natural resources classified source materials, by visual interpretation of Landsat imagery, and by computer-aided analysis of Landsat digital data. Comparison of irrigated cropland estimates among these three maps shows differences within two percent of one another. Comparison of compilation times point favorably to using computer analysis of Landsat data. Based to using computer analysis of Landsat data. Based on the results of this study, plans are being made to use Landsat data to map irrigated cropland throughout the rest of an eight-state area served by the High Plains aquifer. Most scenes will be mapped by visual interpretation of Landsat imagery so that both methods can be compared for other areas within the High Plains. (Author's abstract) W87-10043

COBALT DETERMINATION IN NATURAL WATERS USING CATION-EXCHANGE LIQUID CHROMATOGRAPHY WITH LUMINOL CHEMILUMINESCENCE DETEC-

MINOL CHEMILUMINESCENCE DELECTION,
Massachusetts Inst. of Tech., Cambridge. Dept. of
Earth, Atmospheric and Planetary Sciences.
E. A. Boyle, B. Handy, and A. van Geen.
Analytical Chemistry ANCHAM, Vol. 59, No. 11,
p 1499-1503, June 1987. 6 fig, 2 tab, 19 ref.

Descriptors: \*Water analysis, \*Geochemistry, \*Analytical methods, \*Chromatography, \*Chemiluminescence, \*Cobalt, Natural waters, Heavy metals, Detection limits.

## Evaluation, Processing and Publication—Group 7C

A method has been developed for the analysis of cobalt in natural waters by cation-exchange liquid chromatography using luminol chemiluminescence detection. Cobalt can be determined directly in freshwater samples on 500-microliter samples with a detection limit of 20 pmol/kg; larger samples provide proportionately lower detection limits. Seawater samples can be analyzed on 100-mL samples following APDC solvent extraction; the detection limit of this method is 5 pmol/kg. The precision of the method is + or - 5%. The method should also be applicable to the analysis of V, Cu, and Fe in natural waters. Equipment is low in cost and transportable and can be used in the field. (Author's abstract) A method has been developed for the analysis of (Author's abstract) W87-10073

STABLE ISOTOPE DILUTION ANALYSIS OF HYDROLOGIC SAMPLES BY INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY, Geological Survey, Denver, CO.
J. R. Garbarino, and H. E. Taylor.
Analytical Chemistry ANCHAM, Vol. 59, No. 11, p 1568-1575, June 1987. 4 fig, 10 tab, 34 ref.

Descriptors: \*Mass spectrometry, \*Natural waters, \*Analytical methods, \*Water analysis, \*Heavy metals, \*Isotope dilution, Ions, Performance evaluation, Measuring instruments.

Inductively coupled plasma mass spectrometry is employed in the determination of Ni, Cu, Sr, Cd, Ba, Tl, and Pb in nonsaline, natural water samples by stable isotope dilution analysis. Hydrologic samples were directly analyzed without any unusual pretreatment. Interference effects related to overlapping isobars, formation of metal oxide and multiply charged ions, and matrix composition were identified and suitable methods of correction evaluated. A comparability study showed that were identified and suitable methods of correction evaluated. A comparability study showed that single-element isotope dilution analysis was only marginally better than sequential multielement isotope dilution analysis. Accuracy and precision of the single-element method were determined on the basis of results obtained for standard reference materials. The instrumental technique was shown to be ideally suited for programs associated with certification of standard reference materials. (Author's abstract) thor's abstract) W87-10074

#### 7C. Evaluation, Processing and Publication

HYDROLOGICAL FORECASTING: DESIGN AND OPERATION OF HYDROLOGICAL FORECASTING SYSTEMS,
World Meteorological Organization, Geneva

World Meteorological Organization, Geneva (Switzerland). Dept. of Hydrology and Water Re-For primary bibliographic entry see Field 7B. W87-09630

COMPARISON OF OFFICE-DERIVED VS. FIELD-DERIVED WATER TABLE MAPS FOR A SANDY UNCONFINED AQUIFER, Wisconsin Geological and Natural History Survey, Madison. For primary bibliographic entry see Field 2F. W87-09672

DYNAMIC THRESHOLD METHOD FOR OB-TAINING CLOUD COVER FROM SATELLITE IMAGERY DATA, National Center for Atmospheric Research, Boul-

der. CO.

der, CO. J. A. Coakley. Journal of Geophysical Research (D) JGRDE3, Vol. 92, No. 4, p 3985-3990, April 1987. 4 fig, 9 ref. NASA Grant 1922-CL-215.

Descriptors: \*Cloud cover, \*Dynamic threshold method, \*Satellite imagery, \*Cloud size, \*Data interpretation, \*Remote sensing, Estimating,

Errors in cloud cover derived by using a fixed threshold applied to imagery data depend not only

on the fractional cover but also on cloud size. As a result, a fixed threshold applied to two scenes having the same cloud cover will produce different estimates of the cover when the clouds in the two scenes have different sizes. To allow for this influence due to cloud size, a dynamic threshold method is presented. In this method an infrared threshold is adjusted to achieve the highest corre-lation between the threshold-derived cloud cover lation between the threshold-derived cloud cover systems this threshold achieves a cancellation of errors in the cloud cover for the subregions so that the resulting cloud cover for the region and the associated estimates of cloud properties are in fair agreement with estimates obtained using the spatial coherence method. The agreement illustrates the validity of the layered cloud model used in different ways by the two methods. The performance of the dynamic threshold method is contrasted with that of a fixed threshold applied to the same data in order to illustrate the merits of applying a scene-dependent threshold. (Author's abstract) W87-09692

MEASUREMENTS OF SURFACE ENERGY BUDGETS IN THE ROCKY MOUNTAINS OF

Colorado State Univ., Fort Collins, Dept. of At-

Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.

J. D. Sheaffer, and E. R. Reiter.

Journal of Geophysical Research (D) JORDE3,
Vol. 92, No. 4, p 4145-4162, April 1987. 10 fig, 2
tab, 12 ref. NASA Grant NAGW-601; NSF Grant
ATM 83-13270; USAF Grants AFOSR 82-0162
and AFOSR F49620-85-C-0077.

Descriptors: \*Advection, \*Data interpretation, \*Remote sensing, \*Surface energy balance, Atmosphere, Weather, Climate, Model studies.

The surface energy balance of a mountain valley and a mountain peak were continuously monitored for periods of 126 and 34 days, respectively. The data yielded temporally resolved, high-quality measurements of the radiative, soil, and total atmospheric turbulent heat fluxes. Comparative data for the two sites reveal the effects of terrain setting and surface cover in modulating the heat balance. and surface cover in modulating the heat balance A procedure is suggested for accommodating local advective affects due to variable terrain and suradvective affects due to variable terrain and sur-lace cover to allow partitioning of the total turbu-lent flux into values for sensible and latent heat. This procedure relies on the stability-dependent coefficient of turbulent transfer which is locally calibrated to systematically minimize advection-related errors. Scaling functions for the transfer coefficient are based on the effective blackbody temperature of the surface. Consequently, the pro-cedure offers an opportunity for developing reli-able bulk representations of heat transfer at the surface for use with remote sensing data and with models of the soil and surface cover in complex terrain. (Author's abstract) terrain. (Author's abstract) W87-09698

PROBLEMS IN INTERPRETATION OF POWER SPECTRA OF CLOUD FIELDS, Commonwealth Scientific and Industrial Research Organization, Aspendale (Australia). Div. of At-

mospheric Rese D. M. O'Brien. pheric Research.

Journal of Geophysical Research (D) JGRDE3, Vol. 92, No. 5, p 5522-5532, May 1987. 12 fig, 16 ref, append.

Descriptors: \*Model studies, \*Power spectra, \*Data interpretation, \*Dynamic threshold method, \*Satellite imagery, \*Cloud size, \*Data interpretation, Estimating, Remote sensing, Clouds, Atmostration, Estimation, E

A recurrent suggestion in the literature is that the spatial variability of cloud might best be studied through the power spectrum of the cloud field. In this paper this proposal is examined in the context of radiative transfer by broken cloud. Through the analysis of numerical models in one and two dimensions, three conclusions are drawn: (1) Fields mensions, three conclusions are drawn; (1) results with the same power spectrum may transmit different average fluxes, so the power spectrum alone does not determine the radiative transfer. (2) The power spectrum of both the models and real cloud

fields (advanced very high resolution radiometer satellite images) oscillate so rapidly that quantitative analysis of the power spectrum is very sensitive to the manner in which the power spectrum is sampled. The most stable analysis of the power spectrum involves integration over all spatial frequencies. It will be shown how this procedure quencies. It will be shown how this procedure permits the calculation of infrared transfer in a one-dimensional cloud model. (3) A proposal for a satellite-mounted optical Fourier analyzer is examined, the need to compress the data by logarithmic sampling of the power spectrum impairs the resolution of the correlation function of the cloud field. Furthermore, the degradation of the resolution in-creases with the correlation length. (Author's abstract) W87-09700

MICROCOMPUTER-BASED FLUOROMETRIC DATA LOGGING SYSTEM FOR FLOW AND DISPERSION MEASUREMENTS,

DISPERSION MEASUREMENTS, University of Strathclyde, Glasgow (Scotland). Dept. of Physics. S. G. Wallis, C. Blakeley, and P. C. Young, Journal of the Institution of Water Engineers and Scientists JIWSDI, Vol. 41, No. 2, p 122-134, April 1987. 5 fig, 27 ref. Natural Environment Research Council Research Grant GR3/5171.

Descriptors: \*Microcomputers, \*Data logging, \*Data interpretation, \*Dispersion, \*Path of pollutants, \*Tracers, \*Streamflow, Fluorometers, Tem-

This paper describes the development and oper-ation of a microcomputer-based data logging and analysis system for use in fluvial tracer studies. The data logging system consists of an Epson HX-20 microcomputer interfaced, via a microelectronic analogue to digital converter, to a Turner Designs field fluorometer. As well as recording fluorescence intensities and water temperatures, the microcomputer also controls the sensitivity range of the fluorometer. Data are transferred to a BBC Model B microcomputer system for subsequent analysis. Some illustrative results, obtained using the data logging and analysis system in a study of logitudinal dispersion in streams, are presented. (Author's abstract) W87-09706

TRANSFER OF INFORMATION AMONG WATER QUALITY VARIABLES OF THE PO-TOMAC RIVER. PHASE III: TRANSFERABLE

TOMAC RIVER. PHASE III: TRANSFERABLE AND TRANSFERRED INFORMATION, George Washington Univ., Washington, DC. International Water Resources Inst. H. B. Harmanciogulu, and V. Yevjevich. Available from the National Technical Information Service, Springfield, VA 22161, as PB87-172656/. AS. Price codes: A05 in paper copy, A01 in microfiche. D.C. Water Resources Research Center, Washington, DC. Report No. 72, June 1986. 81 p. 13 fig., 43 tab, 15 ref. Contract No. 14-08-0001-G 1009. USGS Project No. G1009-03.

Descriptors: \*Water quality, \*Information transferability, \*Information transfer, \*Information exchange, \*Statistics, \*Statistics, analysis, Water quantity, Structural analysis, Time series, Trends, Seasonality, Serial dependence, Independent random series, Autoregressive modeling, Correla-tion and regression, Correlation coefficient, Coeffi-cient of determination, Information correlation co-

The study of water quality variables of the Potomac River shows various difficulties in the transfer of information from water quantity and some water quality variables to other water quality variables of relatively small number of observations. ables of relatively small number of observations. Sets of data collected by various agencies are not compatible in several ways. Using several best sets of these water quality data of the Potomac River, a method has been developed to compute the correlograms from the uneven spacing of water samples, and then to find the simple (AR-1 and AR-2) autoregressive models. Structural analysis of correlation of variables of each level of this analysis show that hasically periodicities in parameters and show that basically periodicities in parameters and time stochastic dependence are responsible for

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whatever correlation is found. The independent stochastic components in general show very small or negligible relationships. (Harmancioglu-George Washington Univ.) W87-09750

SELECTED HYDROLOGIC DATA FROM THE NORTHERN PART OF THE HUECO BOLSON, NEW MEXICO AND TEXAS, Geological Survey, Albuquerque, NM. Water Resources Div.

For primary bibliographic entry see Field 2F. W87-09809

COMPARISON OF UNREGULATED AND REGULATED STREAMFLOW FOR THE YAKIMA RIVER AT UNION GAP AND NEAR PARKER

Geological Survey, Tacoma, WA. Water Re-For primary bibliographic entry see Field 2E. W87-09811

CLIMATIC DATA FOR WILLIAMS LAKE, HUBBARD COUNTY, MINNESOTA, 1984, Geological Survey, Lakewood, CO. Water Resources Div. For primary bibliographic entry see Field 2H. W87-09815

RIVER-QUALITY ASSESSMENT OF THE TRUCKEE AND CARSON RIVER SYSTEM, CALIFORNIA AND NEVADA -- HYDROLOGIC CHARACTERISTICS.

Geological Survey, Sacramento, CA. Water Resources Div. For primar W87-09816 ary bibliographic entry see Field 6G.

HYDROLOGIC DATA FOR THE SOUTH-CENTRAL AREA, NEBRASKA, Geological Survey, Lincoln, NE. Water Resources

Div. For primary bibliographic entry see Field 2E. W87-09818

PHYSICAL AND CHEMICAL DATA FOR THE SACRAMENTO RIVER AT RIO VISTA, CALI-FORNIA, JANUARY THROUGH MAY, 1983, Geological Survey, Menlo Park, CA. Water Resources Div

For primary bibliographic entry see Field 5B. W87-09819

SUMMARY OF WATER RESOURCES ACTIVI-TIES OF THE U.S. GEOLOGICAL SURVEY IN FISCAL YEAR 1986.

Geological Survey, Lakewood, CO. Water Resources Div.

For primary bibliographic entry see Field 2F. W87-09821

GROUND-WATER DATA FOR THE HANNA AND CARBON BASINS, SOUTHCENTRAL WYOMING, THROUGH 1980, Geological Survey, Cheyenne, WY. Water Re-

For primary bibliographic entry see Field 2F. W87-09823

ACTIVITIES OF THE WATER RESOURCES DIVISION, CALIFORNIA DISTRICT, IN THE 1985 FISCAL YEAR,

Geological Survey, Sacramento, CA. Water Resources Div. For primary bibliographic entry see Field 2E. W87-09825

ANNUAL WHITE WATER-RESOURCES REVIEW SANDS MISSILE RANGE, NEW **MEXICO, 1985,** 

Geological Survey, Albuquerque, NM. Water Resources Div

For primary bibliographic entry see Field 2F. W87-09826

JANUARY 1986 WATER LEVELS, AND DATA RELATED TO WATER-LEVEL CHANGES, WESTERN AND SOUTH-CENTRAL KANSAS, Geological Survey, Lawrence, KS. Water Resources Div. For primary bibliographic entry see Field 2F. W87-09827

GROUND-WATER LEVELS IN ARKANSAS. SPRING 1986

SPRING 1986, Geological Survey, Little Rock, AR. Water Re-For primary bibliographic entry see Field 2F. W87-09828

BACKGROUND HYDROLOGIC INFORMA-TION IN POTENTIAL LIGNITE MINING AREAS IN MISSISSIPPI, AUGUST 1985, Geological Survey, Jackson, MS. Water Resources

For primary bibliographic entry see Field 5B. W87-09831

GROUND-WATER LEVELS IN THE ALLUVI-AL AQUIFER IN EASTERN ARKANSAS, 1984, Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 2F.
W87-09833

SUMMARY OF AVAILABLE GROUND-WATER DATA FOR THE ISLAND OF OAHU,

HAWAII, Geological Survey, Honolulu, HI. Water Re-sources Div. For primary bibliographic entry see Field 2F. W87-09836

RECORDS OF WELLS AND CHEMICAL ANALYSES OF GROUND WATER IN BROWN COUNTY, SOUTH DAKOTA, Geological Survey, Huron, SD. Water Resources

For primary bibliographic entry see Field 2F. W87-09837

PHYSICAL AND CHEMICAL DATA FOR THE SACRAMENTO RIVER AT RIO VISTA, CALI-FORNIA, NOVEMBER 1983 THROUGH NO-VEMBER 1984, Geological Survey, Menlo Park, CA. Water Re-

sources Div. For primary bibliographic entry see Field 5B. W87-09841

PRINCIPAL FACTS FOR GRAVITY STATIONS IN PARADISE AND STAGECOACH VALLEYS, HUMBOLDT AND LYON COUNTIES NEVADA.

Geological Survey, Carson City, NV. Water Resources Div.

sources Div.

D. H. Schaefer, B. G. Duffrin, and R. W. Plume.
Available from USGS, OFSS, Box 25425, Denver,
CO 80225. USGS Open File Report 85-694, 1986.
15 p, 3 fig, 1 tab, 3 ref.

Descriptors: \*Gravity studies, \*Geophysics, \*Nevada, Gravimetric prospecting, Paradise Valley, Stagecoach Valley.

Principal facts for 178 gravity stations in Paradise Valley and 117 stations in Stagecoach Valley, are tabulated; they consists of latitude, longitude, altitude, observed gravity, free-air anomaly, terrain correction, and Bouguer gravity anomaly values at a bedrock density of 2.67 grams per cubic centimeter. (USGS) W87-09842

COMPILATION OF WELL AND GROUND-WATER QUALITY DATA FOR SELECTED WELLS NEAR BLACKFOOT, IDAHO,

Geological Survey, Boise, ID. Water Resources For primary bibliographic entry see Field 2F. W87-09843

KANSAS GROUND-WATER OBSERVATION-WELL NETWORK, 1985, Geological Survey, Lawrence, KS. Water Re-

For primary bibliographic entry see Field 2F. W87-09844 ources Div.

SELECTED GEOHYDROLOGIC DATA FOR THE MESILLA BASIN, DONA ANA COUNTY, NEW MEXICO, AND EL PASO COUNTY,

TEXAS, Geological Survey, Albuquerque, NM. Water Re-For primary bibliographic entry see Field 2F. W87-09845

STAGE-DISCHARGE RELATIONS FOR BLACK WARRIOR RIVER AT WARRIOR DAM NEAR EUTAW, ALABAMA--UPDATED 1985, Geological Survey, Montgomery, AL. Water Resources Div. For primary bibliographic entry see Field 2E. W87-09846

HYDROLOGIC DATA FOR THE SOUTHERN SAND HILLS AREA, NEBRASKA, Geological Survey, Lincoln, NE. Water Resources

For primary bibliographic entry see Field 2E. W87-09847

HYDROGEOLOGIC DATA FROM A 2,000-FOOT DEEP CORE HOLE AT POLK CITY, GREEN SWAMP AREA, CENTRAL FLORIDA, Geological Survey, Orlando, FL. Water Resources Div.

For primary bibliographic entry see Field 2F. W87-09848

WATER RESOURCES OF LAKE AND MOODY COUNTIES, SOUTH DAKOTA,
Geological Survey, Houston, TX. Water Re-

sources Div. For primary bibliographic entry see Field 2E. W87-09849

HYDROGEOLOGIC AND WATER-QUALITY CHARACTERISTICS OF THE CRETACEOUS AQUIFER, SOUTHWEST MINNESOTA, Geological Survey, St. Paul, MN. Water Re-

Geological Survey, St. Paul, Min. Water Resources Div.
D. G. Woodward, and H. W. Anderson.
Available from USGS, OFSS, Box 25425, Denver,
CO 80225. USGS Water-Resources Investigations
Report 84-4153, 1986. 16 fig, 1 tab, 2 plates, 30 ref.

Descriptors: \*Aquifer characteristics, \*Water quality, \*Geohydrology, \*Maps, \*Minnesota, Cretaceous aquifer, Dakota formation.

The Cretaceous aquifer in southwest Minnesota consists of discontinuous, basal sandstone beds in the Dakota Formation and the overlying Codell Sandstone Member of the Carlile Shale of the Colorado Group. These sandstone beds are not laterally or vertically persistent throughout the area and generally are separated shale beds in the Dakota Formation and in the overlying Colorado Group of Cretaceous age. Water in the Cretaceous aquifer is confined by overlying shale and by overlying till as much as 700 feet thick. Locally where the drift is permeable and thin and where the shale is missing, water in the aquifer is unconfined. The Cretaceous aquifer in southwest Minnesota is missing, water in the aquifer is unconfined.

Groundwater moves away from the Sioux Quartzite Ridge north toward the Minnesota River, south
toward Iowa, and eastward toward the Mississippi River. Recharge to the aquifer primarily is by infiltration of precipitation that percolates through the overlying drift and underflow in the aquifer from South Dakota. Water in the Cretaceous aquifer consists of five chemical types based on pre-

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dominant ions; including calcium-magnesium bi-carbonate, calcium-magnesium sulfate, sodium chloride, sodium bicarbonate, and sodium sulfate type waters. Dissolved-solids, chloride, and sulfate concentrations in the aquifer locally exceed stand-ards recommended by the U.S. Environmental Protection Agency for public supplies, particularly in areas southwest of the Minnesota River. (USGS)

WATER RESOURCES OF THE SOUTHEAST

LOWLANDS, Geological Survey, Rolla, MO. Water Resources

For primary bibliographic entry see Field 2E. W87-09855

GEOHYDROLOGY OF THE GLACIAL-OUTWASH AQUIFER IN THE BATAVIA AREA, TONAWANDA CREEK, GENESEE COUNTY, NEW YORK, Geological Survey, Ithaca, NY. Water Resources Div.

For primary bibliographic entry see Field 2F. W87-09859

POTENTIOMETRIC MAP OF THE LOWER WILCOX AQUIFER IN MISSISSIPPI, FALL

Geological Survey, Jackson, MS. Water Resources

For primary bibliographic entry see Field 2F. W87-09863

SUMMARY OF HYDROLOGIC INFORMA-TION FOR THE DENVER COAL REGION, COLORADO,

Geological Survey, Lakewood, CO. Water Resources Div.

sources Div.

J. M. Norris, S. G. Robson, and R. S. Parker.

Available from USGS, OFSS, Box 25425, Denver,
CO 80225. USGS Water-Resources Investigations

Report 84-4337, 1985. 68 p. 34 fig. 11 tab, 109 ref.

Descriptors: \*Coal mining, \*Groundwater, \*Hydrologic data, \*Surface waters, \*Water quality, \*Denver Coal basin, \*Colorado, Alluvial aquifers, Aquifers, Average flow, Flood discharge, Flow duration, Low flow.

A literature review of available hydrologic information for the Denver coal region is presented. Where little information is available, data from the U.S. Geological Survey's WATSTORE data base are summarized. The information is divided into three categories: surface water, surface water quality, and groundwater. Data generally are lacking on surface water and surface water quality. The on surface water and surrace water quanty. In effects of man's activities on streamflow quantity and quality are not known. Considerable literature is available on the major aquifers in the area, but less is known about the shallow groundwater system. (USGS)
W87-09866

DRAINAGE OF A MINE TO A CONSTANT LEVEL (DRENAJE DE UNA MINA HASTA NIVEL CONSTANTE),

Granada Univ. (Spain). Dept. de Quimica Inorgan-

For primary bibliographic entry see Field 4B. W87-09871

STOCHASTIC MODEL FOR THE STUDY OF THE DRAINAGE DENSITY IN THE UPPER BASIN OF THE DARRO RIVER (GRANADA) (UN MODELO ESTOCASTICO PARA EL ES-TUDIO DE LA DENSIDAD DE DRENAJE DE LA CUENCA SUPERIOR DEL RIO DARRO (GRANADA)),

Granada Univ. (Spain). Dept. de Estadistica Matematica.

For primary bibliographic entry see Field 2E. W87-09872

RELIABILITY AND THE FACTOR OF SAFETY DUE TO PIPING,

Purdue Univ., Lafayette, IN. School of Civil Engineering. For primary bibliographic entry see Field 2G. W87-09873

SYSTEMS APPROACH FOR MINE WATER

CONTROL,
Mining Development Central Inst., Budapest (Hungary). For primary bibliographic entry see Field 4B. W87-09874

MATHEMATICAL SIMULATION OF HY-DRAULIC NETWORK TO DRAIN MINE AND CONSTRUCTION WORK, Geotest Brno (Czechoslovakia). For primary bibliographic entry see Field 2F. W87-09875

FREE SURFACE FLOW IN POROUS MEDIA BY FINITE ELEMENT METHODS, Minho Univ., Braga (Portugal). For primary bibliographic entry see Field 2E. W37-09876

SEEPAGE CHARACTERISTICS THROUGH AN ABANDONED TAILINGS PILE, Idaho Univ., Moscow.

For primary bibliographic entry see Field 5B. W87-09877

UNDERGROUND MINE DRAINAGE QUANTITY AND QUALITY GENERATION MODEL, Ohio State Univ., Columbus. Dept. of Civil Engineering.

For primary bibliographic entry see Field 5B. W87-09878

COMPLEX CONTINUUM MODEL FOR DE-SCRIPTION OF THE SIMULTANEOUS SCRIPTION OF THE SIMULTANEOUS SOLID-FLUID MOVEMENTS, Technical Univ. of Heavy Industry, Miskolc (Hun-

gary).
For primary bibliographic entry see Field 8E.
W87-09879

AQUIFER PARAMETER IDENTIFICATION BY USING DIGITAL SIMULATION MODELS, Water Resources Directorate, Punjab (India). For primary bibliographic entry see Field 2F. W87-09880

REDUCING WATER LEAKAGE INTO UNDER-GROUND COAL MINES BY AQUIFER DEWA-

Argonne National Lab., IL. Energy and Environ-mental Systems Div. For primary bibliographic entry see Field 4B. W87-09881

DRAINAGE AND STABILITY PROBLEMS OF TALUSES IN AN OPEN PIT EXCAVATION IN MARQUESADO (PROBLEMES D'EXHAURE ET STABILITE DES PENTES DANS LA MINE A CIEL OUVERT DU MARQUESADO), Ecole Nationale Superieure des Mines de Paris

For primary bibliographic entry see Field 2F. W87-09882

APPLICATION OF A SIMULATION MODEL FOR A LARGE-SCALE KARSTIC WATER AQ-UIFER, Mining Development Central Inst., Budapest

(Hungary). For primary bibliographic entry see Field 2F. W87-09883

ELEMENT BALANCE METHOD OF HYDRO-GEOLOGIC COMPUTATION, Hydrogeologic Co. of the Ministry of the Metal-lurgical Industry, Beijing (China).

For primary bibliographic entry see Field 2F. W87-09884

COMPUTER ANALYSIS OF WATER PUMP IN THE LLANO MINE (TERUEL, SPAIN) (ANALI-SIS POR ORDENADOR DE LOS BOMBEOS EN LA MINA LLANO (TEREUL-ESPANA), Granada Univ. (Spain). Grupo de Trabajo de Hidrogeologia. For primary bibliographic entry see Field 2F. W87-09885

DRAINAGE IN SPANISH MINING (EL DESA-GUE EN LA MINERIA ESPANOLA), Rios Rosas, Madrid (Spain). For primary bibliographic entry see Field 4B. W87-09896

COMPUTATION OF FLOOD FLOWS IN OPEN

Institut za Vodoprivredu Jaroslav Cerni, Belgrade For primary bibliographic entry see Field 2E. W87-09903

WATER CAPACITY OF ABANDONED WORK-INGS IN UNDERGROUND COAL MINES, Glowny Inst. Gornictwa, Katowice (Poland). For primary bibliographic entry see Field 4B. W87-09905

DETERMINATION OF THE TRANSMISSI-VITY OF COASTAL AQUIFERS BASED ON THE OBSERVATION OF SINUSOIDAL, ON-DULATORY, TRANSITORY REGIMES IN-DUCED BY TIDAL OSCILLATIONS, INITEC, General Mola, 120, Madrid, Espana. For primary bibliographic entry see Field 2F. W87-09906

EMPIRICAL ANALYSIS OF PASSIVE MICRO-WAVE OBSERVATIONS FROM BHASKARA-II SAMIR AND REMOTE SENSING OF ATMOS-PHERIC WATER VAPOR AND LIQUID WATER.

Indian Space Research Organization, Ahmedabad. Space Applications Centre. For primary bibliographic entry see Field 7B. W87-0990

COMPARISON OF NORTHERN SPHERE SNOW COVER DATA SETS, Maryland Univ., College Park. Dept. of Meteorol-

J. Scialdone, and A. Robock.
J. Scialdone, and A. Robock.
Journal of Climate and Applied Meteorology
JCAMEJ, Vol. 26, No. 1, p 53-68, January 1987.
10 fig, 1 tab, 27 ref. NOAA Grant NA84AA-H00026 and NSF Grant ATM-8213184.

Descriptors: \*Data comparison, \*Data interpreta-tion, \*Snow cover, \*Comparison studies, Northern hemisphere, Satellite technology, Estimating,

Four Northern Hemisphere snow cover data sets are compared on a weekly basis for the 25-month period July 1981 through July 1983. The data sets are the NoAA/NESDIS Weekly Snow and Ice Chart, the Composite Minimum Brightness (CMB) Chart, the U.S. Weekly Weather and Crop Bulletin (data only for North America), and Air Force data. The NoAA/NESDIS chart is produced through the use of photo-interpretation of visible satellite imagery and ground observations. The U.S. Crop Bulletin is also done manually, using only ground observations. The CMB chart and the Air Force data are both produced using automated processes, the first by way of visible satellite imagery and the second by way of ground observations, climatology, satellite observations and persistence. Since the NoAA/NESDIS chart is the only standard and complete data set dating back to only standard and complete data set dating back to the mid 1960s, it is used as the basis for the study. The CMB and the NOAA/NESDIS charts were compared. The CMB frequently overestimated

### Group 7C—Evaluation, Processing and Publication

snow cover, especially the southward extent of the main snow boundary and areas far from the snow boundary which were not present on the NOAA/ NESDIS chart. On numerous occasions, the out-line of mountain ranges was either distorted or totally missed by the CMB. The CMB also undertotally missed by the CMB. The CMB also under-estimated snow cover, especially in densely forest-ed areas. Other regions of underestimation by the CMB can be attributed to the bias factor of the NOAA/NESDIS chart. (The NOAA/NESDIS chart uses the latest snow cover information while the CMB is composited over a week). The U.S. Crop Bulletin agreed fairly well with the NOAA/ NESDIS chart east of the Rockies, but often dif-fered to the west. The Air Force data set, an undocumented operational product, differed quite a bit from the NOAA/NESDIS chart. (Author's abstract)

PREDICTABILITY OF JAVA MONSOON RAINFALL ANOMALIES: A CASE STUDY, Wisconsin Univ.-Madison. Dept. of Meteorology. For primary bibliographic entry see Field 2B. W87-09912

REFLECTIVITY-RAIN RATE RELATION-SHIPS FOR RADAR HYDROLOGY IN BRAZII, Instituto de Pesquisas Espaciais, Sao Paulo

(Brazu). R. V. Calheiros, and I. Zawadzki. Journal of Climate and Applied Meteorology JCAMEJ, Vol. 26, No. 1, p 118-132, January 1987. 18 fig. 1 tab. 9 ref.

Descriptors: \*Data interpretation, \*Brazil, \*Rainfall intensity, \*Rainfall rate, \*Radar, \*Model studies, Rain gages, Rainfall, Precipitation, Rainfall simulators, Simulation, Model testing, Hydrologic models, Mathematical equations, Mathematical studies, Correlation analys

The relation of radar observations to rain rates on the ground can be obtained theoretically by taking into account the various factors affecting the preci-sion of the radar measurements particularly those related to the radar-rainfall distance. Because of the difficulties associated with the large number of factors, an empirical relationship between radar and rain gage measurements is derived through and rain gage measurements is derived through correlation techniques which bypasses the problems of the theoretical approach with two limitations: (1) radar estimates of the rain rate are averages, and (2) a long series of simultaneous radar measurements and a large number of rain gages clocated at various distances within the radar range are required. The latter limitation is a serious one are required. The latter limitation is a serious one since dense rain gage networks are not generally available and are too costly to implement. In order to overcome this difficulty a method is developed based on the concept that if two random variables are functionally related, the correct transformation of one into the other will produce equal probability densities. The relationship between the radar reflectivity factor for rain (Z) and the rainfall rate on the ground (R) was defined through comparison of nonsimultaneous measurements of Z and R according to the presented mathematical equations. according to the presented mathematical equations.

Range dependent relationships obtained in this way are given for a radar situated in Brazil. The way are given for a radar situated in Diazzi. The method is tested by comparing actual river hydro-graphs from a number of basins with those simulat-ed using radar data as input to a hydrological model. (Wood-PTT) W87-09914

AREA-TIME-INTEGRAL TECHNIQUE TO ESTIMATE CONVECTIVE RAIN VOLUMES OVER AREAS APPLIED TO SATELLITE DATA OVER AREAS APPLIED TO SATELLITE DATA - A PRELIMINARY INVESTIGATION, South Dakota School of Mines and Technology, Rapid City. Inst. of Atmospheric Sciences. A. A. Doneaud, J. R. Miller, L. R. Johnson, T. H. Vonder Haar, and P. Laybe.
Journal of Climate and Applied Meteorology JCAMEJ, Vol. 26, No. 1, p 156-169, January 1987.
10 fig, 2 tab, 24 ref. NASA Grant NAG-5-386.

Descriptors: \*Data interpretation, \*Remote sensing, \*Rainfall, \*Rainfall volume, \*Radar, \*Area-

Time-Integral technique, Convective precipitation, Precipitation, Great Plains, Estimating.

Early work attempting to apply GOES rapid scan satellite data to a recently developed simple radar technique used to estimate convective rain volumes over areas in a semiarid environment (the northern Great Plains) is described. Called the Area-Time-Integral technique (ATI), it provides a means of estimating total rain volumes over fixed and floating target areas. The basis of the method is the existence of a strong correlation between the radar echo area coverage integrated over a lifetime of the storm and the radar estimated rain volume. The technique does not require the consideration of the structure of the radar intensities to generate rain volumes, but only the area covered by radar echoes. This might reduce the errors generated by the structure differences between the radar and the satellite signatures above given thresholds. The the structure differences between the radar and the satellite signatures above given thresholds. The convective rain volume of a convective cluster was computed by application of the ATI technique based only on satellite data. (Author's abstract) W87-09915

AROUND THE WORLD - WATER, WATER ALMOST EVERYWHERE..., National Environmental Satellite, Data, and Information Service, Washington, DC. For primary bibliographic entry see Field 2B. W87-09926.

IN THE UNITED STATES - FLASH FLOODS AND DROUGHT,

AND DROUGHT, National Environmental Satellite, Data, and Infor-mation Service, Washington, DC. For primary bibliographic entry see Field 2E. W87-09927

SNOWFALL - BELOW AVERAGE, For primary bibliographic entry see Field 2C. W87-09928

METEOSAT AND RADAR RAINFALL IMAGE-RY INTERPRETATION ON THE NIGHT OF 20/21 NOVEMBER 1986, Meteorological Office, Bracknell (England).

Meteorological Magazine MTMGA5, Vol. 116, No. 1376, p 87-91, March 1987. 5 fig, 5 ref.

Descriptors: \*Radar imagery, \*Radar, \*Data interpretation, \*Rainfall, \*Weather forecasting, England, Wales, Weather, Satellite technology, Thunderstorms, Rainstorms, Precipitation, Convective

Satellite and radar imagery often reveal striking patterns. Correct interpretation of the imagery can improve weather prediction, especially of short-period forecasts. Examples of imagery in near real time of the severe weather conditions including thunderstorms and heavy rain in an area extending from south-east Wales to the eastern English channel on 20/21 November 1986 are shown and important signatures are highlighted. A tornado at Swindon and a waterspout at Selsey were further examples of some of the mesoscale convective benomena observed within the circulation of the examples of some of the mesoscare convective phenomena observed within the circulation of the deepening depression that moved eastwards across England and Wales which could be related to key signatures from the imagery from Meteosat and the UK weather radar network. (Wood-PTT) W87-09943

PRELIMINARY EVALUATION OF INITIAL ATMOSPHERIC MOISTURE FROM THE TIROS-N SOUNDING SYSTEM,

National Environmental Satellite, Data, and Information Service, Washington, DC. Forprimary bibliographic entry see Field 7B. W87-09974

FLOOD APPLICATIONS OF SATELLITE IM-Atmospheric Environment Service, Downsview For primary bibliographic entry see Field 7B. W87-09995

ASSESSING THE RED RIVER OF THE NORTH 1978 FLOODING FROM NOAA SAT-ELLITE DATA,

National Environmental Satellite, Data, and Information Service, Washington, DC.
For primary bibliographic entry see Field 7B.
W87-09997

PRELIMINARY ANALYSIS OF SAR MAPPING OF THE MANITOBA FLOOD, MAY 1979, INTERA Environmental Consultants Ltd.,

INTERA Environmental Consultations 2004, Ottawa (Ontario).
R. T. Lowry, E. J. Langham, and N. Mudry.
IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Peccora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 316-323, 6 fig. 2 ref.

Descriptors: \*SAR, \*Radar, \*Remote sensing, \*Hydrology, \*Mapping, \*Satellite technology, \*Flooding, \*Red River, \*Data interpretation, \*Manitoba, Radar, Photography, Maps.

In the spring of 1979, the Red River rose to near record levels flooding large areas in southern Manitoba. The flooded areas were mapped as part of the SURSAT Program using the ERIM (Envi-ronmental Research Institute of Michigan) fourronmental Research Institute of Michigan) four-channel radar. The radar was operated in the pseudo satellite model with the antenna pointing steeply downwards. Flying with minimum over-lap, the Red and Morris River basins were mapped and mosaics were made of the X-HH and L-HH imagery and compared to photo mosaics made from 70 mm aerial photography. The mosaics were compared and the differences caused be vegeta-tion, etc. in the extent of flooding indicated were compared and the differences caused be vegeta-tion, etc., in the extent of flooding indicated were noted. The presentation includes examples of both the X and L band imagery and the resulting flood extent maps. The differences between these two maps and that drawn from photos are discussed and conclusions on the implication for flood moni-toring using satellite borne SAR systems are drawn. (See also W87-09953) (Author's abstract) W87\_00008

DELINEATION OF DRAINAGE AND PHYSIO-GRAPHIC FEATURES IN NORTH AND SOUTH DAKOTA USING NOAA-5 INFRARED

National Environmental Satellite, Data, and Information Service, Washington, DC.
For primary bibliographic entry see Field 2E.
W87-09999

SOIL MOISTURE APPLICATIONS OF THE HEAT CAPACITY MAPPING MISSION, South Dakota State Univ., Brookings. Remote

Sensing Inst.
J. L. Heilman, and D. G. Moore.

J. L. Hellman, and D. G. Moore.

IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 371-376, 7 fig. 5 ref. NASA Contract No. NAS5-24206.

Descriptors: \*Soil water, \*Mapping, \*Soil temperature, \*South Dakota, \*Hydrology, \*Remote sensing, \*Satellite technology, Radiometry, Temperaing, \*Satellite technolog ture, Data interpretation

Results of ground, aircraft, and satellite investiga-tions are presented that demonstrate the potential for using data from NASA's Heat Capacity Map-ping Mission (HCMM) satellite to provide infor-mation on near surface soil moisture. The satellite carries a two-channel radiometer (0.5 to 1.1 and 10.5 to 1.7 sincepal is carries a two-channel radional to 1.5 to 1.2.5 micron) in a sun synchronous orbit and collects data at approximately 0230 and 1330 local standard time with repeat day-night coverage every five days over South Dakota. Near surface soil moisture influences surface temperature through conductivity heat transfer (affected by thermal inertia) and evaporation. Thus, HCMM data acquired near maximum and minimum periods

## Structures-Group 8A

of the diurnal temperature cycle can provide useful soil moisture information. Hydrologic interpreta-tions of HCMM data are complicated by vegeta-tion, evapotranspiration, topography, atmospheric absorption, and other environmental variables such as solar radiation, temperature, wind, etc. (See also as solar radiation, temperature, wind, etc. (See also W87-09953) (Author's abstract)

LANDSAT DATA FOR LOCATING SHALLOW GLACIAL AQUIFERS IN EASTERN SOUTH

DAKOTA, South Dakota School of Mines and Technology, Rapid City. Dept. of Geology and Geological En-

For primary bibliographic entry see Field 7B. W87-10006

HYDROGEOLOGIC INTERPRETATIONS OF LANDSAT IMAGERY IN ARID ZONES OF SOUTH AND WEST AFRICA, Bundesanstalt fuer Geowissenschaften und Roh-stoffe, Hanover (Germany, F.R.).

Storie, nanover (Jeannary, Proceedings of the Fifth N. Kruck. IN: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 408-415, 3 fig, 11 ref.

Descriptors: \*Geohydrology, \*LANDSAT, \*Africa, \*Groundwater potential, \*Arid zones, \*Groundwater data, \*Hydrology, \*Data interpretation, \*Upper Volta, \*Niger, \*Botswana, \*Satellite technology, \*Remote sensing, \*Aquifers, Groundwater quality, Groundwater recharge, Infiltration, Saling mater,

A hydrogeological investigation of LANDSAT imagery was carried out in an area covering 170,000 sq km of northern Botswana. Interpretation of Neotectonics and paleogeography in association with borehole and well records studies led to a regional representation of groundwater conditions in the Kalahari beds, with special regard to groundwater salinity. Fossil strandlines detected under alluvial and aeolian cover indicate former extensive lakes during a wetter climate. Their drying out led to an increase of groundwater salinity. under alluvial and acolian cover indicate former extensive lakes during a wetter climate. Their drying out led to an increase of groundwater salinity over extensive areas. Evaporation in recent remant pans, where the groundwater level reaches the Earth's surface, has further intensified groundwater salinity in the immediate pan areas. Locally, fresh groundwater recharge takes place in recent inland deltaic deposits during periods of high water. Basement rocks crop out throughout most of Upper Volta. It is known that groundwater reservoirs in this kind of rock can be expected crust. Lineations mapped on Landsat imagery can be used as indications for local groundwater exploration. In the western part of the Republic of Niger, the geometric arrangement of surface drainage and aerolian sediments indicate fossil alluvium beneath dunes. It is presumed that river water infiltrates into the alluvium during the rainy season, thus recharging the local aquifers. (See also W87-09953) (Author's abstract)

GROUND WATER EXPLORATION PROGRAMS IN AFRICA,

Earth Satellite Corp., Chevy Chase, MD. For primary bibliographic entry see Field 2F.

OBSERVATIONS ON LAKE ONTARIO BASIN HYDROGEOLOGY FROM OPTICAL ENHANCEMENTS OF LANDSAT IMAGERY, Regional Remote Sensing Facility, Nairobi (Kenya). For primary bibliographic entry see Field 7B. W87-10009

LANDSAT CLASSIFICATION OF COASTAL WETLANDS IN TEXAS,
Texas Univ. at Austin. Bureau of Economic Geol-

For primary bibliographic entry see Field 7B. W87-10012

USING LANDSAT MSS DATA WITH SOILS INFORMATION TO IDENTIFY WETLAND HARITATS Purdue Univ., Lafayette, IN. Dept. of Forestry

and Natural Resources.
For primary bibliographic entry see Field 7B.
W87-10014

IMPROVEMENTS IN LAKE VOLUME PRE-DICTIONS USING LANDSAT DATA, National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. For primary bibliographic entry see Field 2H. W87-10015

LANDSAT HYDROBIOLOGICAL CLASSIFI-CATION FOR AN INLAND FRESH WATER MARSH WITHIN EVERGLADES NATIONAL

PARK, Everglades National Park, Homestead, FL. South Florida Research Center. P. W. Rose, and P. C. Rosendahl. In: Satellite Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p 485-491, 6 fig, 1 tab, 3 ref.

Descriptors: \*LANDSAT, \*Classification, \*Marshes, \*Everglades National Park, \*Remote sensing, \*Hydrology, \*Shark River Slough, \*Satellite technology, \*Wetlands, Spectral analysis, Data

The hydrologic balance of the Florida Everglades directly influences all ecological aspects of the region. This intricate ecosystem is dependent on fresh water supplies which must be furnished in sufficient quantity and at appropriate rates to achieve ecosystem maintenance. Orbital remote sensing satellites (Landsat) have provided a comprehensive and repetitive survey of the multivariant hydrologic parameters over both the accessions. prehensive and repetitive survey of the multivariant hydrologic parameters over both the accessibe and inaccessible regions of Everglades National Park. Landsat multispectral data were analyzed for application to the Shark River Slough, an inland fresh water marsh in Everglades National Park. An interactive multispectral processor utilizing Landsat digital tapes generated hydrographic maps through classification of the slough and definition of the surface radiance characteristics of the wetlands areas in the park. The spectral response of each hydrobiological zone was determined and plotted. The spectral relationships plots were useful for formulating multispectral relationships plots were useful for formulating multispectral relationships between the reflectances from the slough in order to determine the best possible band combinations to enhance classification results. The resultant classification was of great importance in determining to determine the best possible band combinations to enhance classification results. The resultant classification was of great importance in determining the extent of each hydrobiological zone in the Shark Slough and in establishing flow vectors for water movement throughout the slough. The application of hydrologic remotely sensed data will provide greater utility in formulating a sound water resources management program for Everglades National park. (Author's abstract)

LANDSAT INTERPRETATION OF PRAIRIE LAKES AND WETLANDS OF EASTERN SOUTH DAKOTA, South Dakota State Univ., Brookings. Remote Sensing Inst. R. G. Best, and D. G. Moore. IN: Satellise Hydrology. Proceedings of the Fifth Annual William T. Pecora Memorial Symposium on Remote Sensing, Sioux Falls, South Dakota, June 10-15, 1979. 1981. p. 499-506, 6 fig., 3 tab, 15 ref. USGS Contract No. 14-08-0001-13576.

Descriptors: \*LANDSAT, \*Prairies, \*Lakes, \*Wetlands, \*South Dakota, \*Hydrology, \*Remote sensing, \*Data interpretation, \*Satellite technology, Statistical models, Hydrologic models, Monitoring, Aerial photography.

Landsat imagery can be used to monitor changes in surface area of prairie lakes and wetlands, specif-ically in eastern South Dakota. Landsat MSS-7 provides the greatest contrast between open water and vegetation and can be used for delineating

surface water boundaries for morphometric measurements. Volume and changes in volume of the water bodies can be estimated by utilizing area measurements in a statistical model. The model water oodies can be estimated by utilizing area measurements in a statistical model. The model developed in this project accounted for more than 95% of the variance in volume of the 89 lakes used to develop the model. The data from interpretations of Landsat imagery can be integrated with ground sampling in hydrologic modeling. Stratifications of prairie lakes based on tonal variations in different MSS bands can be used to locate quality differences and reduce redundant sampling in a ground based water quality study. Photographic enhancement techniques can be used to improve the interpretability of Landsat imagery. These techniques include simple enlargements and more complicated enhancement techniques. Thematic extractions of surface water bodies are made by greatly increasing the contrast off a scene. The occurrence and distribution of emergent vegetation and small emergent filled wetlands as well as open water bodies can be interpreted on temporal composites of spring and winter scenes. (Lantz-PTT) W87-10018

COMPARATIVE STUDY OF EIGHT MATHEMATICAL MODELS FOR THE RELATIONSHIP BETWEEN WATER TEMPERATURE AND HATCHING TIME OF EGGS OF FRESHWATER FISH, Biological Association, Windermere

Freshwater (England). For primary bibliographic entry see Field 2H. W87-10097

METHODOLOGY FOR OPTIMAL DESIGN OF PIPE DISTRIBUTION NETWORKS. Ottawa Univ. (Ontario). Dept. of Civil Engineer-For primary bibliographic entry see Field 5F. W87-10106

RECURSIVE WATER QUALITY FORECAST-ING MODELS FOR URBAN CATCHMENTS, G. G. Patry. Canadian Journal of Civil Engineering CJCEB8, Vol. 14, No. 2, p 221-229, April 1987. 11 tab, 34

Descriptors: \*Urban hydrology, \*Water quality forecasting, \*Path of pollutants, \*Model studies, \*Catchment areas, \*Urban areas, \*Drainage, \*Sewer systems, Data interpretation, Ontario, Forecasting, Prediction, Water quality.

Urban water quality forecast models for use in real-time integrated control of combined sewer systems are developed and applied to a small com-bined sewer system in Hamilton, Ontario. Water bined sewer system in Hamilton, Ontario. Water quality forecasts for lead times ranging from 5 to 60 min are provided for both suspended solids and chemical oxygen demand. Two modelling approaches are examined: (a) a statistical approach based on the formulation of autoregressive moving-average models with exogenous inputs and (b) a two-stage deterministic/stochastic model based on the first-order surface pollutant washoff model. While both groups of model yield comparable forecasts in terms of the mean absolute percent average models where quality forecasts, statistically based error in water quality forecasts, statistically based models were found to provide definite operational advantages. (Author's abstract)

#### 8. ENGINEERING WORKS

#### 8A. Structures

DESIGN ASPECTS OF BARRIER PILLARS AGAINST WATER-LOGGED WORKINGS IN COAL MINING OPERATIONS, Nottingham Univ. (England). Dept. of Mining En-

gineering.
B. N. Whittaker, and R. N. Singh.
IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volumes I, 1984. SIAMOS 78. p 675-692, 11 fig, 13 ref.

#### Field 8—ENGINEERING WORKS

#### Group 8A-Structures

Descriptors: \*Mining engineering, \*Mine drainage, \*Piles, \*Coal mining, \*Structural engineering, Coal mines, Subsurface drainage, Stress analysis, Design criteria, Groundwater movement, Flow race, Drainage engineering, Fracture permeability, Flow observatives:

A progress report on current research into the long term stability of barrier pillars with special reference to permeability of water at collieries in the United Kingdom is given. Coal rib pillars are required to be not less than 37 m in width. Findings to data indicate that the current design practices for specifying the width of such pillars provides an ample margin of safety for UK conditions even though the design methods were established without any reference to permeability aspects. The even though the design methods were established without any reference to permeability appects. The fracture zone skirting the edge of a rib pillar can extend to as deep as 10 m for shallow workings before the pillar core begins to make a significant contribution to virtually eliminating flow; more knowledge is required for deeper mining situations. The deeper workings give rise to more intensive fracturing of the rib pillar edges with resulting increased flow properties. The simple instrumentation used to investigate the permeability of coal rib pillars has proven successful under difficult geotechnical conditions. Laboratory investigations proved a valuable aid to gaining an insight into the flow properties of fractured coal under different states of stress; at a deviatoric stress level of 50-60 states of stress; at a deviatoric stress level of 50-60 MPa, the resulting sample compaction virtually eliminated flow through the broken coal. (See also W87-09568) (Geiger-PTT) W87-09669

DESIGN AND CONSTRUCTION OF SEA DEFENCES AT SHEERNESS,

Southern Water Authority, Chatham (England).

I.E. Robson

Journal of the Institution of Water Engineers and Scientists JIWSDI, Vol. 41, No. 2, p 107-121, April 1987. 7 fig, 5 ref, append.

Descriptors: \*Sheerness, \*Construction, \*Sea defense works, \*Breakwaters, \*Seawalls, Design standards, England, Architecture.

Sheerness and the adjacent towns of West Minster Sheemess and the adjacent towns of West Minster and Queenborough, total population approximately 21000, occupy the north-western part of the Isle of Sheppey. The paper presents a general review of the development and construction of sea defence works in the area. The extent of the works in the program comprises nearly 9 km of defences. The design gained the approval of conservation bodies and has been recognized for improving generally the appearance of the area and enhancing the period architecture in the buildings opposite. (Alexander-PTT) exander-PTT) W87-00704

HYDRAULIC DESIGN ALGORITHMS FOR UPGRADING AND ENHANCING WATER DIS-TRIBUTION SYSTEMS,

Water Resources Research Inst., Lexington.

For primary bibliographic entry see Field 5F. W87-09792

'METRO' IN LYON, FRANCE. CONSTRUC-TION BELOW THE WATER TABLE (METRO DE LYON, CONSTRUCTION SOUS LE NIVEAU DE LA NAPPE PHREATIQUE), Societe d'Economie Mixte du Metropolitain de l'Agglomeration Lyonaise (France).
For primary bibliographic entry see Field 4B.
W87-09870

CONTROL AND DRAINAGE OF WATER IN MINE TAILINGS DAMS, Carleton Univ., Ottawa (Ontario). Dept. of Civil

Engineering. For primary bibliographic entry see Field 5G. W87-09894

DESIGN FEATURES AT TJODAN SAVE TIME AND MONEY.

Norconsult A/S, Sandvika (Norway). A. Palmstrom, and K. Schanche. International Water Power and Dam Construction IWPCDM, Vol. 39, No. 6, p 19-24, June 1987. 11 fig. 8 ref.

Descriptors: \*Pressure shaft, \*Intakes, \*Tjodan, \*Design criteria, \*Economic aspects, \*Hydroelectric power, \*Dams, Norway, Concretes, Construction, Water pressure.

The Tjodan hydro scheme in Norway incorporates an unlined pressure shaft 1250 m in length; this design allowed a considerable cash saving and also reduced the construction time by approximately two months. The first part of this article deals with the design and construction pressures taken for the two months. The first part of this article deals with the design and construction measures taken for the 880 m-head unlined pressure shaft. The latter part deals with a new concept for sealing of the concrete section at the base of the pressure shaft which has been introduced at the project; this has proved to be an effective method for shafts subjected to high water pressures. (Author's abstract) W87-10101

HYDROPOWER TUNNELS IN PERMAFROST,

HTDROFOWER TUNNELS IN FERMACKOSI, LICconsult, Copenhagen (Denmark).
T. S. Jacobsen, and H. Mai.
International Water Power and Dam Construction IWPCDM, Vol. 39, No. 6, p 26-27, 33-35, June 1987. 4 fig, 2 ref.

Descriptors: \*Soil mechanics, \*Hydroelectric power, \*Permafrost, \*Model studies, \*Design criteria, \*Ice formation, \*Water tunnels, Dams, Construction, Greenland, Risk analysis.

Design of Greenland's first hydroelectric powerplant necessitates studies of the thermal regime around the water tunnels in the permafrozen rock. Computerized models have been developed to cal-culate the risk of ice formation in the tunnels. This article describes the results of the calculations and the impact on the design and operation of the power station. (Author's abstract) W87-10102

USE OF TILTMETERS FOR MEASURING ARCH DAM DISPLACEMENTS,

Motor-Columbus Ingenieurunternehmung A.G., Baden (Switzerland). For primary bibliographic entry see Field 8G. W87-10103

INSTRUMENTATION PRACTICE FOR SHORT-TERM MONITORING OF CIVIL

Telemec, Asnieres (France). For primary bibliographic entry see Field 8G. W87-10104

AUTOMATIC PLUMBLINE MONITORING SYSTEM.

Bureau of Reclamation, Denver, CO. For primary bibliographic entry see Field 8G. W87-10105

MODIFICATIONS TO THE DESIGN PROCE-DURE FOR GRIT CHAMBERS, S. K. Agrawal, and J. K. Bewtra. Canadian Journal of Civil Engineering CJCEB8, Vol. 14, No. 2, p 216-220, April 1987. 3 fig, 1 tab, 7

Descriptors: \*Settling basins, \*Channel flow, \*Grit chambers, \*Design criteria, \*Shear stress, Beds, Velocity, Construction, Engineering.

A Modified approach to the design of grit cham-bers has been suggested. This approach is based on the concept of critical shear stress at the bed rather than mean velocity. It is recognized that the rela-tionship between critical bed shear stress and mean tionship between critical oed shear stress and mean velocity in a channel is not constant, but varies according to the flow conditions. Critical bed shear stress values, obtained in the laboratory for different particle characteristics, are given. The proposed method should provide a more rational

and a better design procedure for grit chambers. (Author's abstract) W87-10107

#### 8B. Hydraulics

DYE STUDIES OF INITIAL DILUTION AND THE APPLICABILITY OF THE STAGNANT WATER DESIGN,

National Research Inst. for Oceanology, Stellenbosch (South Africa). Hydrodynamics and Water Quality Div.

For primary bibliographic entry see Field 5E. W87-09650

INTRINSIC FREQUENCY SPECTRA SHORT GRAVITY-CAPILLARY WAVES OB-TAINED FROM TEMPORAL MEASURE-MENTS OF WAVE HEIGHT ON A LAKE, Washington Univ., Seattle. Dept. of Atmospheric Sciences.

For primary bibliographic entry see Field 2H. W87-09714

MATHEMATICAL MODELS OF SEDIMENT EFFECTS ON WATER RESOURCES SYSTEMS, Mississippi Univ., University. Center for Computational Hydroscience and Engineering.
For primary bibliographic entry see Field 2J.

## 8C. Hydraulic Machinery

METHODOLOGY FOR OPTIMAL DESIGN OF PIPE DISTRIBUTION NETWORKS,

Ottawa Univ. (Ontario). Dept. of Civil Engineer-

For primary bibliographic entry see Field 5F. W87-10106

PERFORMANCE OF SMALL PROGRESSIVE CAVITY PUMPS WITH SOLAR POWER, P. R. B. Ward, W. G. Dunford, and D. L. Pulfrey.

Canadian Journal of Civil Engineering CJCEB8, Vol. 14, No. 2, p 284-287, April 1987. 5 fig, 8 ref. NRCC Contract 01SX-31926-3-3030 and BCSC Grant 4RC10.

Descriptors: \*Cavity pumps, \*Solar power, \*Water supply, Groundwater, Domestic water use, Design criteria, Performance evaluation.

A small progressive cavity pump, rated at about 900 W, has been assembled and tested as part of a photovoltaic-cell-powered water pumping system. Torque-speed relationships for the progressive cavity pump, not readily available in published engineering journals, were measured and are preengineering journals, were measured and are pre-sented. The pump was extremely well suited to lifting groundwater for small (domestic) supplies with solar power because it was capable of produc-ing the full design head over a very wide range of speeds. In addition, the progressive cavity pump was robust, and unlike most other positive dis-placement pumps, would tolerate small concentra-tions of silt and sand in the water without damage. Very many of these pumps are already in use in parts of Africa and other developing areas, and excellent prospects exist for operating progressive cavity pumps with solar-energy-powered drives.
(Author's abstract) W87-10112

### 8D. Soil Mechanics

HYDROPOWER TUNNELS IN PERMAFROST. LICconsult, Copenhagen (Denmark). For primary bibliographic entry see Field 8A. W87-10102

### Grants, Contracts, and Research Act Allotments—Group 9D

#### 8E. Rock Mechanics and Geology

METHODOLOGY AND APPLICATION OF ANALYSING ROCK-WATER INTERACTION

ENDANGERING MINES, Mining Development Central Inst., Budapest (Hungary).

IN: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Vol-umes I, 1984. SIAMOS 78. p 637-655, 4 fig, 45 ref.

Descriptors: \*Rock mechanics, \*Rock excavation, \*Mining engineering, \*Rock testing, \*Geohydrology, Simulation analysis, Model studies, Groundwater movement, Seepage, Mathematical models, Hydrologic models.

A survey of practical methods used in mining, oil production and geotechnics for investigating the mechanical movements of rock-water systems is given. A new strategy of investigation based on testing devices is suggested and demonstrated on several examples. The strategy involves reducing motions in the double system of less intensive interaction to a one phase problem for the whole time process by considering constant material characteristics. For more intensive interaction, the process should be divided into partial processes. If the test model characteristics are to be derived only from subsequently collected empirical data, use of analogies is suggested. Models were proposed for evaluating the strength characteristics of floor side protective layers in Hungarian mining conditions and the conditions of protective layers in the roof of the Velenje lignite mines in Yugoslavia. Although the strategy of investigation proved suitable for solving the present problems, it is not to be considered as a panacea for other cases of strange interaction within the rock-water system. (See also W87-09568) (Geiger-PTT) A survey of practical methods used in mining, oil

COMPLEX CONTINUUM MODEL FOR DESCRIPTION OF THE SIMULTANEOUS SOLID-FLUID MOVEMENTS, Technical Univ. of Heavy Industry, Miskolc (Hun-

gary). R. Richter, and E. Bobok

R. Richter, and E. Bodok. In: Water in Mining and Underground Works (El Agua en la Mineria y Trabajos Subterraneos), Volume II, 1984. SIAMOS 78. p 883-897, 5 ref.

Descriptors: \*Rock mechanics, \*Rock properties, \*Data interpretation, Continuum mechanics, Mathematical studies, Mathematical equations, Rocks, Pores, Mathematical models, Solid-fluid flows.

The fundamental concepts, definitions and laws of continuum mechanics applying to non-homogene-ous systems of rock, water, and gas are presented. All scalar, vector and tensor fields are multiplied, All scalar, vector and tensor fletds are multiplied, as multiplied the number or the phases. On the basis of these simultaneous field concepts the equations of change for mass, momentum and energy are presented. (See also W87-09568) (Author's ab-W87-09879

#### 8G. Materials

UTILIZATION OF PLASTIC PIPE FOR SUB-MARINE OUTFALLS - STATE OF THE ART, VBB/SWECO Consulting Group, Stockholm (Sweden).

nary bibliographic entry see Field 5E.

USE OF TILTMETERS FOR MEASURING ARCH DAM DISPLACEMENTS,

Motor-Columbus Ingenieurunternehmung A.G., Baden (Switzerland). P. J. Deinum

International Water Power and Dam Construction IWPCDM, Vol. 39, No. 6, p 38-40, June 1987. 4 fig, 3 ref.

Descriptors: \*Tiltmeters, \*Arch dams, \*Dam dis-placement, \*Measuring instruments, Inclinometer, Monitoring, Emosson dam, Switzerland, Costs.

The suitability of a tiltmeter (electronic inclinome-In e suitability of a titimeter (electronic inclinometer) for monitoring displacements in concrete arch dams was verified during a trial installation at the Emosson dam in Switzerland. The low installation cost of this instrument could make it particularly appropriate for retrofitting old dams where no plumbline shafts are available. (Author's abstract) W87-10103

INSTRUMENTATION PRACTICE FOR SHORT-TERM MONITORING OF CIVIL

WORKS, Telemec, Asnieres (France). J. L. Bordes, and P. J. Debreuille. International Water Power and Dam Construction IWPCDM, Vol. 39, No. 6, p 45-47, June 1987. 4

Descriptors: \*Measuring instruments, \*Civil engineering, \*Dams, \*Monitoring, Technology, Performance evaluation, Case studies.

Mutually consistent and complementary sets of instruments now exist for installing in or on engineering structures and foundations, which are capable of measuring the smallest displacements and resolving them into their component parts. More important than the identification of the many different kinds of component factors, however, is the fact the the resolution of these instruments is so fine that the engineer can have a significant response within a few minutes, hours or months, and can monitor cyclic or reversible effects as they occur. Short-term monitoring in a civil engineering can monitor cyclic or reversible effects as they occur. Short-term monitoring in a civil engineering context means a short time-span relative to the reference period or the magnitude of the phenomenon being monitored. Stressed here is the importance of high resolution rather than high precision, because it is an absolute quality independent of the time factor. Precision, on the other hand, is related to the length of time of observation and is affected by various types of drift and disturbing factors. High resolution is only valuable if the instrument remains stable in the short term (in the engineering sense) with minimum scatter or noise in the readings. If this requirement is met, resolution can be thought of as equivalent to instantaneous precision.

AUTOMATIC PLUMBLINE MONITORING SYSTEM.

SYSTEM, Bureau of Reclamation, Denver, CO. L. Carpenter, T. Hutchcroft, and N. Herz. International Water Power and Dam Construction IWPCDM, Vol. 39, No. 6, p 47-50, June 1987. 3

Descriptors: \*Measuring instruments, \*Plumblines, \*Concrete dams, \*Deflection, Monitoring, Dams, Automation, Optical sensors.

Manually read plumbline deflection systems have been used for many years to track the annual cyclic movements of concrete dams. A technique using optical X-Y sensors, combined with a micro-processor-based controller, forms a powerful digi-tal plumbline monitoring system. Installation of the system in several dams in the USA has provided an opportunity for continuous surveillance of these opportunity for continuous surveillance of these structures. (Author's abstract)
W87-10105

## 9. MANPOWER, GRANTS AND FACILITIES

#### 9B. Education (In-House)

FIVE YEAR PLAN, SOUTHERN PLAINS REGION OF THE WATER RESEARCH INSTITUTE PROGRAM, U.S. GEOLOGICAL SURVEY, WATER PROBLEMS AND RESEARCH PRIORITIES, Resources Research Inst., Still-

water. L. E. Mack, U. Singh, T. G. Bahr, N. N. Durham,

and W. R. Jordan.

Available from the National Technical Information Available from the National Technical Information Service, Springfield, VA 22161, as PB86-153053/ AS. Price codes: A02 in paper copy, A01 in micro-fiche. November 1985. 14 p, 9 ref, append.

Descriptors: \*Planning, \*Information exchange, \*Water management, \*Oklahoma, Priorities, Depletion, Water supply, Interagency cooperation.

A summary of the water resources problems of the Southern Plains Region of the Water Research Southern Plains Region of the Water Research Institute Program is presented. Problems discussed include: pollution of surface and groundwater; inadequate supply of surface water; groundwater depletion; flooding and drought management; and socio-economic and legal interactions. Using these repollers of being response to the surface of problems as a basis, regional water research priorities are presented and discussed. (McTernan-Okla.WRRI) W87-09770

#### 9C. Research Facilities

METHOD FOR IDENTIFYING WATER RE-SOURCES RESEARCH NEEDS AND SETTING PRIORITIES AMONG THEM.

Tennessee Univ., Knoxville. Water Resources Re-search Center.

For primary bibliographic entry see Field 6B. W87-09772

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN MINNESOTA,

FISCAL YEAR 1985, Geological Survey, St. Paul, MN. Water Re-

Geological Survey, St. Faul, Mar. Wales Resources Div.
J. A. Jannis.
Available from USGS, OFSS, Box 25425, Denver,
CO 80225. USGS Open File Report 86-133, 1986.

Descriptors: \*Water resources, \*Research and development, \*Water resources research, \*U.S. Geological Survey, \*Minnesota.

Water-resources activities in the Minnesota District included 26 projects in 1985. The report describes the projects which were funded by 9 local and 6 State agencies, by the U.S. Geological Survey, and by 10 other Federal agencies. (USGS) W87-09820

### 9D. Grants, Contracts, and Research Act Allotments

FISCAL YEAR 1984 PROGRAM REPORT (OHIO WATER RESOURCES CENTER), Ohio State Univ., Columbus. Water Resources

R. C. Stiefel.

R. C. Stefel.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-157021/
AS. Price codes: A04 in paper copy, A01 in micro-fiche. Program Report G-926-01, September 1984, 35 p, append. Contract No. 14-08-0001-G926.
USGS Project No. G926-01.

Descriptors: \*Research, \*Information transfer, Descriptors: "Research, "Information transfer, "Training, "Ohio, Lake Erie, Fluidized bed, Bio-logical treatment, Phosphorus, Bioavailable phos-phorus, Nutrients, Habitat, Wetlands, Herbicides, Agricultural runoff, Water quality, Eutrophication, Sediment transport, Mixing.

Water is one of Ohio's most important natural resources, and the State has an abundant supply to meet its immediate needs. Most of Ohio's water problems are associated with water quality. Of concern are the sediments, nutrients and acids in the surface waters from urban, agricultural and mining areas and the toxic and hazardous wastes that threaten the ground and surface waters. The focus of the 1984 State Water Research Program was directed at some of these needs. One project investigated the operational parameters of a fluid-

### Field 9-MANPOWER, GRANTS AND FACILITIES

## Group 9D-Grants, Contracts, and Research Act Allotments

ized bed bioreactor for the treatment of a wastewater to establish the optimal design and operating criteria for the unit. Three of the projects explored the significance of phosphorus to projects explored the significance of prosputions the State's surface water quality: one developed a technique to estimate the amount of dissolved phosphorus being transported by agricultural runoff; a second better defined the role that agricultural herbicides have in inhibiting photosynthesis and the removal of nutrients in streams in the Lake Erie Basin, and a third project investigated the relationships that exist between bioavailable and non-bioavailable particulate phosphorous in Lake Erie. Other projects attempted to manipulate Lake Erie. Other projects attempted to maniputate the fish population in Lake Erie by changing the type of habitat within the regions managed wellands by altering the depth of water; and exploring the quantities of materials involved in the transport the quantities of materials involved in the transport of sediment and nutrients from the Lake Erie shoreline to the off-shore waters. The Center's technology transfer program assisted in the development of a computer program to estimate the soil loss resulting from surface runoff on agricultural lands. (USCIS)

FISCAL YEAR 1984 PROGRAM REPORT (MICHIGAN INSTITUTE OF WATER RE-

Michigan State Univ., East Lansing. Inst. of Water

Research.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB86-168093.
AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G-913-01, September 1985.
31 p. Contract No. 14-08-001-G913. USGS Project
No. G913-01.

Descriptors: \*Research, \*Information transfer, \*Michigan, Training, Copper, Toxicity, Ground-water pollution, Nitrates, Spatial distribution, Irrigation, Biocontrol, Fish management, Aliphatic hydrocarbons, Halogens, Computer models.

Research projects funded by the Michigan Institute of Water Research to address various water quality problems and issues include the following: (1) R.E. Keen and S.T. Bagley quantified the toxicity and mutagenic potential of a pollutant associatrly and intragenic potential or a pointial association ed with the spent copper ores from mining toward the fish population in a previously contaminated lake in Houghton County. (2) K.M. Kittleson and F.M. D'Itri evaluated groundwater nitrate conr.M. Dittl' evaluated groundwater intrate con-tamination data through the use of a Geographic Information System and illustrated it spatially on a statewide basis. (3) A project by T.L. Loudon determined the potential of chemigation to control surface and groundwater contamination from agri-culture. (4) D.L. King's research evaluated methods for managing fish populations to control algae and macrophytes in nutrient-enriched lakes. And (5) R.B. Kapuscinski's project developed informa-tion concerning the influence on soil organic matter on the rate and extent of microbial transformatter on the rate and extent of microbial transformation of a selected group of organic priority pollutants. The Technology Transfer Program sponsored technical conferences on A Systems Approach to Conservation Tillage, Coastal Wetlands, and the Interstate Information Exchange for Strategic Water Planning in Michigan. In addition, the proceedings of a 1983 conference on Artificial Reefs in the Great Lakes was published. The Technology Transfer Program continued to develop and present workshops during Agriculture and Natural Resources Week at Michigan State University. Sessions included Farm Pond Management and Improvement, Michigan's Inland Water: Current Demand's - Future Conflicts; and Our Great Lakes: Resources for Growth with Quality. In addition, interactive computer programs continue Lakes: Resources for Growth with Quality. In addition, interactive computer programs continue to be developed including simulation models on construction and management of farm ponds and a citizens' guide to recreational activities in Michigan. (D'Itri-Mich. St. Univ.)

FISCAL YEAR 1984 PROGRAM REPORT (MINNESOTA WATER RESOURCES RE-SEARCH CENTER).

Minnesota Univ., St. Paul. Water Resources Re-

Available from the National Technical Information Service, Springfield, VA 22161, as PB86-157047/ AS. Price codes: A03 in paper copy, A01 in micro-fiche. Program Report No. G-914-01, September 1985. 28 p. Contract No. 14-08-0001-G914. USGS Project No. G914-01.

Descriptors: \*Research, \*Information transfer, \*Training, \*Minnesota, Drought tolerance, Organic pollutants, Biodegradation, Industrial pollution tracking, Karst hydrology, Acid-sensitive lakes, Groundwater pollution, Enteric viruses, Liaison University-State Agencies, Fecal coliforms, Pathogenic viruses, Osmoregulation.

A summary is presented of activities for Fiscal year 1984, covering the period of Oct. 1, 1984 through Sept. 30, 1985. The report describes the through sept. 30, 1985. The report describes the research activities of the Center, its involvement in training water scientists and its efforts in information transfer and the findings of six sponsored projects. These findings include: 1. Unsaturated flow patterns are shown to have higher rates of removal of pentachlorophenol than saturated flows which limit oxygen. 2. Atrazine and nitrates have been detected in water samples examined from two Karst springs in southeastern Minnesota and 3. Coliform bacteria are shown to enter groundwater in wells in Olmstead County, MN following rainfall events that exceed 1/4 inch. 4. Drought tolerance in crop plants showed: that lower water po-tentials of young expanding leaves are the result of solute accumulation, which contributes to the high turgor pressure necessary for growth; that the leaf augur pressure necessary for growth; that the leaf elongation rate and stomatal conductivity relationship is species characteristic; that accumulation in stem cells of drought adapted plants was greater than non adapted plants, and that a drought adaptation includes reducing the vascular bundles and vessels. 5. Laboratory experiments on the effects of acid precipitation on Minnesota lakes and in situ porewater sampling have identified sulfate reduction and cation exchange as major mechanisms of internal alkalinity generation. Efforts to improve liaison between the Water Resources Research Center and State and Federal agencies has resulted in the involvement of eight Univ. researchers from four departments in a cooperative research project with MN Dept. of Natural Resources and State Planning Agency, the USGS and the Natural Resources Research Inst., Univ. of MN, Duluth, MN. (Brown-U of Minn.) W87-09717

FISCAL YEAR 1984, PROGRAM REPORT (NORTH DAKOTA WATER RESOURCES RE-SEARCH INSTITUTE).

North Dakota Water Resources Research Inst., Fargo.

Available from the National Technical Information Service, Springfield, VA 22161, as PB86-157039/ AS. Price codes: A02 in paper copy, A01 in micro-fiche. Program Report G-925-01. September, 1985. 10 p. Contract No. 14-08-0001-G925. USGS Project No. G925-01.

Descriptors: \*Research, \*Information transfer, \*Training, \*North Dakota, Brine disposal, Crude oil, Vadose water, Arsenic, Leaching.

In the fiscal year of 1985 the Institute carried out a program of research development, information dis-semination and research action dealing with water problems important to North Dakota and relevant to other parts of the nation with similar water related problems. The research focus for FY85 was water contamination and water borne soil contamination resulting from oil drilling activities. Special emphasis was given to movement of water and water borne materials through the vadose zone of soil materials. A survey was taken of the extent of soil materials. A survey was taken of the extent of externally visible damage. A few test sites were chosen for specific examination of extent of salt migration from abandoned brine disposal ponds. Both lateral and vertical migration were explored and area mineralogy was characterized. The study is relevant to current as well as past practices since. and area mineralogy was characterized. The study is relevant to current as well as past practices since the injection well technology for brine disposal is apparently imperfect. Significant brine infiltration has been discovered near injection wells in addition to that found near abandoned brine disposal ponds. (USGS)

W87-09718

FISCAL YEAR 1984 PROGRAM REPORT, OKLAHOMA WATER RESOURCES RE-SEARCH INSTITUTE,

Oklahoma Water Resources Research Inst., Still-

N. N. Durham N. N. Durham. Available from the National Technical Information Service, Springfield, VA 22161, as PB86-158243/ AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G-927-01. Sept. 1985. 34 Contract No. 14-08-0001-G927. USGS Project No. 6927-01.

Descriptors: Information exchange, Technology transfer, Groundwater, Acidity, Hydrology, Water pollution, Minerals, Pollutants, Acid precipitation, Atmospheric deposition.

The Institute conducted one conference in FY 1984, bringing together OSU water researchers and administrators. In addition, several speakers, committee meetings, and presentations enhanced the goals of the Director's office by informing and the control of the original of the Director's office by informing and the control of the Director's office by informing and the control of the Director's office by informing and the control of the Director's office by informing and the control of the Director's office by informing and the Director's office by informing an assisting Oklahomans in need of water research information. Douglas Kent named and described four zones, based on geochemical characteristics, to better examine the problems of the Tar Creek/ to better examine the problems of the Tar Creek, Picher mining area in northeastern Oklahoma. The Roubidoux aquifer, which underlies this area, sup-plies water to the area and has the potential for contamination from the mining area. This study of geochemical, geologic and hydrogeologic factors includes information on the transport of the metals origin of acidity, a comparison of surrounding areas, and consideration of fracture trends. James Lange furthered his research in the understanding and treatment of immiscible fluids in soils. The ability of the dielectric measuring technique to monitor the flow and retention of both miscible monitor the flow and retention of both miscible and immiscible components in combination with water offers a new procedure for determining the flow and storage of the immiscible fluid. This research will enhance the treatment and removal of pollutants in groundwater sources. Mark Rockley utilized Fourier Transformed Infrared (FTIR) spectroscopic methods to examine clay minerals and determine the extent and use of the FTIR. The and determine the extent and use of the FTIR. The FTIR was found to be rapid, accurate, and precise. New features were observed by the FTIR-Pas (photoacoustics). Jim Wigington's preliminary analysis of data on the streams and soil of south-eastern Oklahoma shows average-weighted pH values for precipitation are consistently in the range of 4.6 to 4.8, similar to the National Atmos-pheric Denosition Program station pear Clayton. pheric Deposition Program station near Clayton, Oklahoma. An inverse relationship between pH and stream stage existed for three forested watersheds that were monitored. (Redelfs-Okla WRRI)
W87-09719

FISCAL YEAR 1984 PROGRAM REPORT (WASHINGTON WATER RESEARCH

Washington State Water Research Center, Pull-

Available from the National Technical Information avanane from the National Technical Information Service, Springfield, VA 22161, as PB86-170487/ AS. Price codes: A03 in paper copy, A01 in micro-fiche. Program Report G-940-01. September, 1985. 28 p. Contract No. 14-08-0001-G940. USGS Project No. G940-01.

Descriptors: \*Research, \*Information transfer, \*Training, \*Washington, Water conservation, Irrigation, Irrigation scheduling, Forest watersheds, Runoff, Time domain reflectometry, Frost depth, Unfrozen water content, Soil and water conservation, Storm runoff, Water pollution treatment, Mount St. Helens, Fish habitat, Water supply.

Water is a major resource in the Pacific Northwest and the State of Washington. Nineteen dams and hydropower systems provide 80 percent of the power needs of the region. The Columbia-Snake River watersheds irrigate over 4.9 million acres of farmland with another 1.2 million acres being considered. The 50,000 miles of streams and 8,000 freshwater lakes play a major role in the social, recreational, and economic structure of the state. It

## Grants, Contracts, and Research Act Allotments—Group 9D

has become apparent that there is a need to carefully allocate water resources to reduce water use conflicts. This is complicated by the fact that over 40 state and federal agencies have a voice in management of the Columbia River alone. High erosion rates, agricultural drainage, increased use of rivers for water transportation and recreation as well as for industrial and municipal wastes disposal are reducing the state's surface and groundwater quality. The State of Washington Water Research Center program is directed toward informing, educating, and attempting to solve or mitigate these complex water allocation, use, and reuse issues. (Funk-Wash St Univ) W87-09720

FISCAL YEAR 1984 PROGRAM REPORT (WISCONSIN WATER RESOURCES CENTER),
Wisconsin Univ.-Madison. Water Resources

Center.

G. Chesters, and K. Sherman.

Available from the National Technical Information
Service, Springfield, VA 22161, as PB86-158250/
AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G-942-01, September 1985.

42 p. Contract No. 14-08-0001-G942. USGS
Project No. G942-01.

Descriptors: \*Groundwater, \*Research, \*Training, \*Wisconsin, \*Adsorption, Aquifers, Computer models, Dewatering, Information exchange, Mine wastes, Model studies, Pesticides, Technology transfer, Vadose water.

The transport of contaminants to and through the The transport of contaminants to and through the groundwater system was the issue of primary concern addressed by the FY 1984 Wisconsin Water Resources Center program. The research is briefly categorized as: (i) pesticide movement to groundwater from agricultural uses in irrigated sandy soils and vertical and horizontal dispersion of the pesticide movement of the pesticide movement of the pesticide movement of desired and the period of desired period pe and vertical and horizontal dispersion of the pesticide in groundwater; (ii) impact of dewatering a
lead mine on the movement of lead, arsenic, magnesium and sulfate to groundwater; (iii) the importance of adsorption/desorption reactions in the
root and vadose zones of soil in transport of contaminants to groundwater; and (iv) numerical simulation of shallow groundwater flow in a glacial
aquifer. This research helps to establish the minimum amount of information needed to predict
whether particular soils or geologic strata transport materials rapidly to groundwater. An understanding of the evolution of elevated levels of
contaminants in groundwater in areas of long-term standing of the evolution of elevated levels of contaminants in groundwater in areas of long-term metal mining has led to proposals for management strategies to combat these problems. Characteriza-tion of adsorption/desorption kinetics enhances the predictive capability of transport models by pro-viding better rate data for incorporation into the poorly understood reaction terms of the models. Detailed description of shallow groundwater flow systems allows proper siting of landfills and im-proved evaluation of the effects of urbanization on shallow flow systems. (Chester-Univ of Wisc) shallow flow systems. (Chester-Univ of Wisc) W87-09721

FISCAL YEAR 1984 PROGRAM REPORT (MASSACHUSETTS WATER RESOURCES RE-

SEARCH CENTER),
Massachusetts Univ., Amherst. Water Resources
Research Center.

P. J. Godfrey.

r. J. Gourey.

Available from the National Technical Information
Service, Springfield, VA 22161, as PB86-158235/
AS. Price codes: A03 in paper copy, A01 in microfiche. Annual Report, October 1985. 26 p. Contract No. 14-08-0001-G912. USGS Project No.
G912-01.

Descriptors: \*Water resources institutes, \*Massa-chusetts, \*Information exchange, \*Education, In-formation systems, Colleges, Acid rain, Acid streams, Acidic soils, Acidic water, Air pollution fallout, Trees, Forests, Monitoring.

The center program focuses on acid deposition, particularly watershed neutralization and forest vegetation impact. Mechanisms of Acid Neutralization in Watersheds of Central Massachusetts, found that watersheds with greater percentages of stratified drift provide greater acid neutralization.

Weathering of silicate minerals provides the principal source of cations and silica with decomposition of plagioclase feldspar consuming 60% of total neutralized acidity. Surficial geology and hydrology of a watershed permit approximation of the acid of plagioclase feldspar consuming 60% of total neutralized acidity. Surficial geology and hydrology of a watershed permit approximation of the acid neutralization capacity. Sulfate Retention by Forest Soils of Central New England, compared sulfate retention in soils collected in 1962 and revisited in 1984. Extractable soil sulfate may have peaked between 1962 and 1984 so most soils are now releasing not adsorbing sulfate. Influence of Vegetative Succession on Soil Chemistry of the Berkshires, examines the role of vegetative succession in natural acid production, an alternative causal hypothesis to acid deposition. Only the pH of the O-horizon was correlated with stand age, but there were significant influences of stand composition. Conifers or oaks usually had solids with lower pH and basic cation concentrations than sugar maple, white ash or birch. Ozone and Acid Precipitation: Effects on Mycorrhizal Formation and Growth of Watershed Tree Seedlings, examines the separate and combined effects of ozone and acid precipitation on tree seedlings. Long term exposure to ozone inhibits seedling growth, especially root growth. Acid precipitation alone or with ozone showed no effect. Mycorrhizal fungicaused some compensation for growth reductions by ozone. The Acid Rain Monitoring (A.R.M.) with ozone showed no effect. Mycorrhizal fungi caused some compensation for growth reductions by ozone. The Acid Rain Monitoring (A.R.M.) Project is determining the sensitivity of all Massachusetts surface waters and is beginning a similar assessment of public and private water supplies. The Information Transfer Program (and the A.R.M. Project) provides a newsletter, the Acid Rain Report to area meteorologists, several publications of use to researchers, research and students, and coordinated two conferences on acid rain research and the annual UCOWR conference. (Godfrev-U Massa) frey-U Mass) W87-09722

FISCAL YEAR 1984 PROGRAM REPORT (WEST VIRGINIA WATER RESEARCH INSTI-

TUTE), West Virginia Univ., Morgantown. Water Re-

Wess Carlo Search Inst.
C. R. Jenkins.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-157070/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G-941-01, October 1982. 23 p. Contract No. 14-08-0001-G-941. USGS Project

Descriptors: \*Research, \*Information transfer, \*Training, \*West Virginia, Acid mine drainage, Bacterial analysis, Coal mines, Coliforms, Groundwater, Pathogens, Chemical potential, Geochemistry, Rock properties, Alluvial deposits, Geomorphology, Land reclamation, Wetlands, Mathematical models, Computer models, Information systems, Terrain models, Water quality.

tems, Terrain models, Water quality.

The Institute program for 1984 was planned in collaboration with State and federal agencies. Four research projects and one technology transfer project supporting nine students were supported by the program. Gary Bissonnette investigated the presence of standard plate count bacteria and opportunistic pathogens in rural groundwater supplies. Over 70% of the wells had total coliform densities exceeding public health standards. The opportunistic pathogens Aeromones hydrophila was detected in several of the supplies. John Renton and Alfred Stiller studied the acid producing potential of various rock lithologies. The data quantified the relative toxicity of individual rock units, and pointed out the high potential in coal beds such as the Upper Freeport. The data will provide a basis for an acid prediction model. Robert Behling conducted a geological analysis of the deposits in a wetland exposed during surface mining. Examination of alluvial deposits suggest that valley formation dates back to the early Wisconsian glaciation. Understanding how the wetland was created will be used in recreating the natural environment when mining ceases. Henry Rauch studied completed surface mines to develop a method of predicting post mining acid drainage potential. Surface mines with deep mine drainage shows much more contamination than those without. Downdip mines and certain coal seams gener-

ate more contaminants than undip situations. Robert Eli developed a computer based system capable of handling map data and other descriptive data related to stream and watersheds. The system will be used to manage mine drainage and for granting discharge permits. (Jenkins-WRU) W87-09723

1984 FISCAL YEAR ANNUAL REPORT OF THE MONTANA WATER RESOURCES RE-SEARCH CENTER, Montana State Univ., Bozeman. Wate: Resources Research Center.

Research Center.
H. S. Peavy.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB86-168101/
AS. Price codes: A03 in paper copy, A01 in microfiche. Bozeman. November 1985. 35 p. USGS
Project No. G917-01.

Descriptors: \*Grants, \*Programs, \*Research projects, \*Information transfer, \*Montans, \*Education, Administration, Publications, Universities.

This document describes the FY 1984 program of the Montana Water Resources Research Center. Critical water problems and issues in Montana are outlined and the relevance of projects in the FY 1984 program to those problems and issues is demonstrated. Five research projects that address groundwater quality and quantity, the preparation of drinking water from low temperature surface waters, and the deposition of heavy metals in reservoir sediment are summarized in the form of project synopeses. The information dissemination efforts of the Water Center are also stated in synopsis form. The cooperative nature of the research program is described and student participation in the program is quantified. (Peavy-Montana St Univ) This document describes the FY 1984 program of

FISCAL YEAR 1984 PROGRAM REPORT (VERMONT WATER RESOURCES RESEARCH

CENTER), Vermont Water Resources Research Center, Bur-

J. C. Clausen.
Available from the National Technical Information Service, Springfield, VA 22161, as PB86-170529/AS. Price codes: A02 in paper copy, A01 in microfiche. Program Report G-937-01, December 1985.
17 p. Contract No. 14-08-0001-G937. USGS 17 p. Contract No. Project No. G937-01.

Descriptors: \*Research, \*Information transfer, \*Training, \*Vermont, Acid precipitation, Acid rain, Benthic macroinvertebrates, Algae, Biological tertiary treatment, Soil water, Groundwater, Pesticides, Trout, Streptococcus. \*Research. \*Information transfer.

The critical water resource problems and issues of The critical water resource problems and issues of Vermont such as acid precipitation, and lakes and wetlands management are discussed. Research projects funded by the Vermont Water Resources Center to address these problems and issues includ-ed: (1) relationship between streamflow acidifica-tion and macroinvertebrates, (2) using tree sap-solutes as indicators of leachable soil water solutes, (3) using periphyton for tertiary treatment in cold solutes as indicators of leachable soil water solutes, (3) using periphyton for tertiary treatment in cold climates, (4) methods for identifying pollutant source types based on Streptococcus species, and (5) the effects of atrazine on brook trout behavior. The technology transfer program co-sponsored a conference on septage and sludge and conducted nominal group technique sessions for determining Lake Champlain research priorities. Also a videotape on the health effects of toxic and hazardous materials was developed and the use of a gentape on the neath effects of toxic and nazardous materials was developed and the use of a geographic information system for groundwater management issues in Vermont was demonstrated. (Clausen-Univ of Vermont)

FISCAL YEAR 1984 PROGRAM REPORT (WY-OMING WATER RESEARCH CENTER), Wyoming Water Research Center, Laramie. W. Brocksen.

Available from the National Technical Information Service, Springfield, VA 22161, as PB86-170388/

### Field 9-MANPOWER, GRANTS AND FACILITIES

## Group 9D-Grants, Contracts, and Research Act Allotments

AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G-943-01, September 1985. 38 p, 2 fig, 4 tab. Contract No. 14-08-0001-G943. USGS Project No. G943-01.

Descriptors: \*Research, \*Information transfer, \*Training, \*Wyoming, Water quality, Organic contaminants, Groundwater, Surface water, Trout, Runoff, Snowcover, Irrigation efficiency, Agricul-ture, Water management, Furrow irrigation, Cost-Benefit analysis, Satellite imagery, Montane areas, LANDSAT

Five projects were funded under the FY 1984 program which covered topic areas in water qual-ity problems of particular interest to Wyomimg. Information transfer is doneprincipally by a sym-posium on Wyoming water problems held each year, extension activities, mailings on available publications through a newsletter and participation. publications inrough a newsiter and participation at several meetings held by groups in the State of Wyoming on water issues. A field study on the movement of organic contaminants through the groundwater to surface streams from a wood-treating facility indicated that oily seeps occur into the surface stream. Soil column experiments have surface stream. Soil column experiments have shown that organic contaminants as emulsions move faster through a soil column than a dissolved single compound. Multiple regression models (three) were developed to predict rout abundance in high mountain streams in Wyoming using geomorphic and instream habitat parameters. Correlations between predicted and actual trout abundance for the three models developed were 0.80, 0.75, and 0.37. Correlations between provided the provided that the contraction of the three models developed were 0.80, 0.75, and 0.37. Correlations between senurouser. dance for the three models developed were 0.80, 0.75, and 0.32. Correlations between snowcover and runoff using satellite imagery for drainage basis in Wyoming were developed to provide a basis for estimating expected runoff from snow-cover using the latest satellite data available each year. Dates for beginning, peak and end of spring snowmelt can be predicted. A field evaluation to compaction effort for different furrow shapes for but and included in the control of hydraulic and infiltration characteristics nydrauic and inflitration characteristics to im-prove irrigation efficiency was performed. Furrow shape and compactive effort are both important factors to improve irrigation efficiency and traditional methods of analyzing furrow irrigation were found unsatisfactory because of furrow shape. Two proposed water development projects in Wyoming were used to identify and quantify secondary costs and benefits of economic, demographic and public sector impacts through the use of a computerized sector impacts strongin the use of a computerized impact assessment model. Both projects produced a net public sector surplus at the local level, but deficits for the State overall. (Brocksen-Wyoming) W87-09726

FISCAL YEAR 1985 (DISTRICT OF COLUMBIA FISCAL YEAR 1985 (DISTRICT OF COLUMDIA WATER RESOURCES RESEARCH CENTER), District of Columbia Univ., Washington. Water Resources Research Center.

m. rl. Watt.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB87-165981/
AS. Price codes: A03 in paper copy, A01 in microfiche. Report No. 77, August 1986. 26 p. Contract
No. 14-08-0001-G1009. USGS Project No. G-100901.

Descriptors: \*Water Research Institute, \*Research, \*Information transfer, \*Training, \*District of Columbia, Non-point sources, Urbanization, Statistical methods, Mathematical models, Sedimentation, Erosion, Land use, Water quality, Watersheds,

The D.C. Water Resources Research Center re-search program for FY 1985 focused on problems of major importance to the District of Columbia. These problems included the deterioration of the water quality of urban streams and related institu-tional concerns. This FY 85 Institute final Program tional concerns. This FY 85 Institute final Program Report describes the completed and continuing projects that the D.C. Water Resources Center conducted between August 1, 1985 and July 31, 1986. The projects entitled: 'Application of Non-Point Source Response Functions to General Urban Land Uses,' 'Study of Erosion and Sedimentation of Selected Small Streams in the District of Columbia,' and 'Assessment of the Impact of Non-Point Source Pollutants on the Urban Portion of the Anacostia River,' dealt with a variety of as-

pects of non-point source pollution in urban areas. These studies provided base-line information on the erosion, sedimentation, and water quality issues concerning the District of Columbia. The other projects entitled: 'Mutagenesis of the Metabolite of Nonionic Detergents in Water,' and 'Transfer of Information Among Water Quality Variables of the Potomac River. Phase III: Transferable and Transferred Information,' were more of a fundamental nature. The FY 85 program also included technology transfer activities and training. The conferences and seminars held, focused on aquatic plant management and soil and water conservation. The program also provided for the training of seven students in a variety of fields. (Watt-D.C. W87-09727

FISCAL YEAR 1985 PROGRAM REPORT (GEORGIA WATER RESOURCES RESEARCH

INSTITUTE), Georgia Inst. of Tech., Atlanta. Environmental irces Center.

B. Kann. Available from the National Technical Information Service, Springfield, Virginia. 22161, as PB87-166005, A04 in paper copy, A01 in microfiche, Program Report G-1011-01, August 1986. 44 p, 6 tab. Contract No. 14-08-0001-G-1011. USGS Project No. G1011-01.

Descriptors: \*Water Research Institute, \*Research, \*Information transfer, \*Training, \*Georgia, Water analysis, Electrochemistry, Spectrophotometry, Unit hydrographs, Low-flow frequency, Flood forecasting, Cadmium, Wastewater treatment, Design flow, Streamflow forecasting, Financing, Pricing, User rates, Cost sharing, Water rates, Cost allocation, Bed load, Sediment distribution, Extreme value theory, Cementation.

The FY 1985 Program included the following six research projects: Correlation Detectors for Selective Detection of Pollutants in Natural Waters, by J.L. Anderson. Application of coupled electrochemical and spectrophotometric detectors for extremely sensitive analysis of certain organic compounds in water is being developed by testing a mathematical simulation model, evaluating electrode arrays, and checking the predicted response of the detectors. Instantaneous Unit Hydrographs: A Geomorphologic Approach, by A.P. Georgakakos. For streamflow forecasting, watershed response to rainfall was modelled as a continuous time Markov process, including both surface and sponse to rainfall was modelled as a continuous time Markov process, including both surface and subsurface runoff. Cadmium Recovery from Wastes by Cementation on to Magnesium, by J.P. Gould and B.M. Khudenko. Effective removal of soluble cadmium salts from wastewater was demonstrated by reduction to elemental cadmium with magnesium metal. A Statistical Analysis of Several Facets of Low Stream Flow Distributions, by W.P. McCormick and J.H. Reeves. A general solution is presented for obtaining an asymptotic expression for the sampling distribution on which the QIO value is based. Evaluation of User Charges to Finance Water Projects, by R.M. North, J. Sellers, and J.O. Smith. Existing funding and repayment and J.O. Smith. Existing funding and repayment information is presented, selected cases that deminformation is presented, selected cases that demonstrate application of promising mechanisms are described, and new mechanisms and pricing structures are proposed. Alluvial Streambed Degradation, by T.W. Sturm. Streambed adjustments by scour and fill were predicted with a numerical model and observed in a physical laboratory model. (Kahn-Georgia Inst. Tech)

FISCAL YEAR 1985 PROGRAM REPORT (GUAM WATER AND ENERGY RESEARCH

INSTITUTE).

Guam Univ., Agana. Water and Energy Research Inst. of the Western Pacific.

Available from the National Technical Information Service, Springfield, Virginia 22161, as PB87-165965, A02 in paper copy, A01 in microfiche. Program Report G-1012-1, August 1986. 18 p. Contract No. 14-08-0001-G1012. USGS Project No. G1012-01.

Descriptors: \*Water Research Institute, \*Research, \*Information transfer, \*Training, \*Guam, Water

conveyance, Erosion control, Drainage practices, Leachates, Landfills, Groundwater pollution, Water distribution, Network design, Computer models, Sediment, Stable isotopes, Estuaries, La-

An overview of the Fiscal Year 1985 research and information transfer activities accomplished by the information transfer activities accomplished by the University of Guam Water and Energy Research Institute is given. These activities were sponsored by the Water Research Institute Program Grant of the U.S. Geological Survey and included the following completed projects: 1. Contemporary irrigation practices and traditional irrigation facilities in Yap, Western Caroline Islands, 2. An investigation of surface and groundwaters in the vicinity of Ordot Landfill for Hazardous organic materials; 3. Application of a computerized distribution model to a water distribution system in Micronesia; 4. Distribution and diagenesis of terrigenous sediment in the estuaries and reef flats of Guam. (USGS) W87-09729

FISCAL YEAR 1985 PROGRAM REPORT (IDAHO WATER RESOURCES RESEARCH IN-STITUTE),

SITUTE), Idaho Water and Energy Resources Research Inst., Moscow.
L. Bloomsburg.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-174439/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report No. G-1014-01. August 1986. 22 p. Contract No. 14-08-0001-G1014. USGS Project No. G1014-01.

Descriptors: \*Water Resources Institutes, \*Information exchange, \*Idaho, \*Education, Administration, Training, Irrigation systems, Optimization, Systems analysis, Groundwater management, Appropriations doctrine, Water quality, Chemical analysis, Lakes, Hydrologic Informations Systems, Drinking water, Health aspects.

Synopses are presented for the following research and information dissemination projects: Develop-ment and Evaluation of Procedures for Systems Analysis and Optimization of On-Farm Irrigation Systems; Groundwater Management Under the Appropriation Doctrine; A Chemical Speciation Approach to Evaluate Water Quality Problems in Approach to Evaluate Water Quanty Problems in the Blackbird Mining District, Idaho; Blue-Green Algae Toxicity in Black Lake, Kootenai County, Idaho; A SAS Based Hydrologic Information Stor-age and Retrieval System; and Preparation of a Booklet Dealing with Health Aspects of Drinking Backcountry Water. Information dissemination and workshop activity of the Institute is also reported. (Director-IWRRI)

FISCAL YEAR 1985 PROGRAM REPORT (MAINE LAND AND WATER RESOURCES

Maine Univ. at Orono. Land and Water Resources

Maine Univ. at Grono. Land Technical Information Service, Springfield, VA 22161, as PB87-166013/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G-1021-01, August 1986. 23 p, 3 fig. 1 tab, 14 ref. 4 append. Contract No. 14-08-0001-G1021. USGS Project No. G1021-01.

Descriptors: \*Water Research Institute, \*Research, \*Information transfer, \*Training, \*Maine, Acid rain, Alkalinity, Aquatic fungi, Chemistry of precipitation, Decomposition, Fir trees, Fog, Granites, Heavy metals, Hydrogen ion concentration, Lakes, Landfills, Leachates, Peat, Spruce trees, Toxicity, Trophic level, Waste treatment, Watersheds, Weather patterns

Four research projects and an information transfer component were funded under the FY 85 program: 'Aquatic Fungal Decomposers in Two Adjacent Maine Lakes of Different Acidity' (G1021-02); 'Al-kalinity and Trophic Stability of Deeper Maine Lakes Set in Granitic Watersheds Impacted by Acid Deposition' (-03); 'A Comparison of the pH of Coastal Fogs with the pH of Interior High-Elevation Fogs' (-04); 'Treatment of Leachate

## Grants, Contracts, and Research Act Allotments—Group 9D

from Toxic and Hazardous Wastes' (-06); and 'Information Transfer in Water Resources Management'(-22). The fungus study (02) yielded bases for hypotheses about fungus-invertebrate food web interactions. Further studies are expected to shed some light on deductions such as the build-up of coarse organic debris in acid lakes having more to do with kinds of numbers of invertebrate shredders than with lack of bacteria. Experimentation with lakes in grantitic watersheds affected by the acid deposition (03) revealed that alkalinities have increased significantly since original survees in 1938. deposition (03) revealed that alkalinities have in-creased significantly since original surveys in 1938-44, probably in part from cultural development, reductions in sulfate deposition, and stimulation of forest ecosystems by increased deposition of inor-ganic N. On average, the pH of coastal fog (04) was no different from that of montane cloud fog. Fog pH and chemistry of coastal fog appear to be site-dependent, and coastal fog is more acidic than site-dependent, and coastal fog is more acidic than concurrent rain. Evidence suggests that coastal fog is generated around aerosol pollutants brought in from some distance. The leachate study (06) determined that peat alone is incapable of adequately removing metals to acceptable levels for discharge. However, peat can be used as a pretreatment process to reduce pollutant concentrations prior to conventional treatment. Information transfer (22) conventional treatment. Information transfe was carried out through conferences and pu tions on topics such as private wells, acidic deposi-tion, groundwater protection, coastal water retion, groundwater protection, coastal water re-sources pressures from competing demands, radon, and giardia. Also a set of audiovisual programs on land and water resources was prepared for use in public schools, and the project manager assisted in CES in-service training in public policy education. (Landry-Uni of Maine) W87-09731

FISCAL YEAR 1985 PROGRAM REPORT (MISSOURI WATER RESOURCES RESEARCH SOURI WATER RESOURCES RESEARCH CENTER). Missouri Water Resources Research Center, Co-

lumbia

lumbia.

Available from the National Technical Information Service, Springfield, VA 22161, as PB87-166021/AS. Price codes: A02 in paper copy, A01 in microfiche. Program Report G-1027-01, August 1986. Bp. Contract No. 14-08-0001-G1027. USGS Project No. C1027-01.

Descriptors: \*Research, \*Information transfer, \*Training, \*Missouri, \*Water Research Institute, Wastewater treatment, Soil surveys, Water table, Analysis, Groundwater, Volatile organic compounds, Chromatography, Water treatment, Water filtration, Bacterial removal, Sludge, Heavy metal.

The Missouri Water Resources Research Center's goals are: (1) sponsor, coordinate and administer research projects on Missouri's water problems, (2) provide training opportunities in research for students with an interest for a career in water redents with an interest for a career in water resources and related fields, and (3) conduct an active technology transfer which includes conferences, workshops, newsletters, and water center research reports. Each of the four research projects funded under this grant produced valuable information to Missouri problems, and provided the opportunity for student involvement in water related projects. The four projects are: (a) Alternative On-Site Sewage Disposal for the Lake of the Ozarks Region, (b) Monitoring Volatile Organic Compounds in Groundwater, (c) Effectiveness of Water Treatment Process in Removing Bacterial and Algal Cells from Drinking Water and (d) Modelling a Quantity of Missouri Groundwater Modelling a Quantity of Missouri Groundwater Potentially Influenced by Sludge Disposal. (Clevenger-Missouri Univ) W87-09732

FISCAL YEAR 1985 PROGRAM REPORT (NE-BRASKA WATER RESOURCES CENTER), Nebraska Water Resources Center, Lincoln. Available from the National Technical Information Service, Springfield, VA 22161, as PB87-174421/AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G-1029, August 1986. 31, Contract No. 14-08-0001-G1029. USGS Project Va. 2019.

Descriptors: \*Research, \*Water Resources Institute, \*Information transfer, \*Training, \*Nebraska,

Soil fungi, Soil erosion, Nitrates, Denitrification, Soni tungi, Soni erosion, intrates, Denitrincation, Water treatment, Conjunctive use, Alluvial aquifers, Consumptive use, Evaporation, Transpiration, Evapotranspiration, Water policy, Water law, State courts, Optimization, Model studies, Conjunctive use, Instream flow, Wildlife habitats,

Water problems in Nebraska addressed by 1985 research program projects included: revegetation of previously irrigated sandy soils; nitrate contamination of groundwater; impact of droughts; declining groundwater levels; water policymaking; conjunctive management of surface and groundwater; and maintenance of instream flows for wildlife habitat. Project 02 studied whether disturbed sandy soils are deficient or lacking in vesicular-arbuscular mycorrhizae and if the reintroduction arbuscular mycorrhizae and if the reintroduction of mycorrhizal fungi into these soils in the revegetation process improves the survivorship, growth and reproduction of plants. Project 03 attempted to optimize the denitrification system so that maximum nitrogen removal is achieved while adding minimal organic concentrations. Project 04 is continuing to determine the influences of weather and drought on crop growth, development and yield, and to develop crop specific drought indices capable of assessing the impact of weather on crop production. Project 05 developed a field method for separately measuring soil water evaporation and plant water transpiration using mini-lysimeters. Project 06 investigated the way in which state courts in Nebraska make water policy. Project 07 Project 06 investigated the way in which state courts in Nebraska make water policy. Project 07 is continuing to develop a management model in order to improve management of all components in a conjunctive surface-groundwater system. Project 08 attempted to develop a better understanding of how river discharge patterns interact with other components of the river system to create a certain shape of channel and to determine instream flow requirements for the maintenance of wildlife habitat. (Powers-Univ. of Nebraska) W87-09733

FISCAL YEAR 1985 PROGRAM REPORT (NEW HAMPSHIRE WATER RESOURCES RE-

New Hampshire Univ., Durham. Water Resources Research Center.

P. Ballestero. P. Ballestero.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-177259/
AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G-1031-01, August 1986. 24 p. Contract No. 14-08-0001-G1031. USGS Project No. G1031-01.

Descriptors: \*Research, \*Water Research Institute, \*Information transfer, \*Training, \*New Hampshire, Groundwater, Eutrophication, Pesticides, Biodegradation, Gasoline, Trichlopyr, Mountain stream, Hydraulic regimes, Radon, Water testing

This report covers the activities of the New Hampshire Water Resource Research Center for the period May 20, 1985 through June 30, 1986. The results of five research projects are briefly discussed. Projects included: movement and fate of pesticides, biodegradation of gasoline in aquifers, occurrence of radon in groundwater, monitoring acidification and eutrophication of lakes, and hydraulics of mountain streams. Training and technology transfer/dissemination is also discussed. (Ballestero-Univ. of New Hampshire)

FISCAL YEAR 1985 PROGRAM REPORT (NORTH CAROLINA WATER RESOURCES RESEARCH INSTITUTE).

Raleigh.

Available from the National Technical Information Service, Springfield, VA 22161, as PB87-165957.

AS. Price codes: AO3 in paper copy, AO1 in microfiche. Program Report G-1035-01, August 1986. 37 p. Contract No. 14-08-0001-G1035. USGS Project No. G1035-01.

Descriptors: \*Research, \*Water Research Institute, \*Information transfer, \*Training, \*North Carolina,

Aquatic weed control, Hydrilla, Eutrophication, Algal control, Limiting nutrients, Nutrient requirements, Agricultural drainage, Wetlands, Wetland filters, Septic tanks, Soil moisture retention, Agricultural drainage, Wetlands, Wetland filters, Septic tanks, Soil moisture retention, Watershed protection, Land use, Fish diseases, Water quality.

The North Carolina Water Resources Research Institute FY 1985 research program was funded by the U.S. Department of Interior, Geological Survey (allotment grant and by state and other non-federal funds). The research program was centered on the following areas critical to the North Carolina water resources program: Groundwater management, Protection of surface waters from management, Protection of surface waters from toxics and excessive nutrients, Watershed protection, Urban water management, Coastal water management, Aquatic weed management. Federal funds were used to initiate two new projects and complete work on four others. One new project addressed the issue of water quality and the health of estuarine fishes. Another new project investigated the dispersal mechanisms of the aquatic weed hydrilla. Four studies were completed on the probhydrilla. Four studies were completed on the prob-lem areas of groundwater quality, estuarine water quality protection, and the control of nutrients and algae in lakes and rivers. Additional studies and an information transfer program were supported using state and local government funding. A progress report and/or completion report for those projects receiving U.S. Department of the Interior, Geolog-ical Survey support is included in the Annual Report. (Lambert-UNC-WRRI) W87-09735

FISCAL YEAR 1985 PROGRAM REPORT (NORTH DAKOTA WATER RESOURCES RE-SEARCH INSTITUTE), North Dakota Water Resources Research Inst.,

Fargo. R. C. Schnell.

R. C. Schnell.

Available from the National Technical Information Service, Springfield, VA 22161, as PB87-166047/
AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G-1036-01. August 1986. 26 p. 1 fig. Contract No. 14-08-0001-G1036, USGS Project No. G1036-01.

Descriptors: \*Water Research Institute, \*Research, \*North Dakota, \*Training, Critical salinity, Groundwater contamination, Pesticides, Leaching, Spatial distribution, Water table, Cropland

Research projects selected for funding in FY 85 dealt primarily with the presence, fate, and transfer of agricultural chemicals in soil and water. Chemicals selected for study included picloram, alachlor, cals selected for study included picloram, alachlor, atrazine, triallate, and glyphosate. Another project assessed the critical depth and critical salinity of groundwater in 68 sites in the Red River Valley. Since these projects were funded on a two year cycle, most results are preliminary in nature. Information transfer activities were quite limited and were confined to providing requested reprints and Institute reports. Publications from these projects will not be expected uptil next year. Approximatemistrate reports. Fublications from these projects will not be expected until next year. Approximately, seven graduate students at the M.S. and Ph.D.levels received financial support from this grant. (Schnell-N. Dakota Univ.)

FISCAL YEAR 1985 PROGRAM REPORT (OREGON WATER RESOURCES RESEARCH INSTITUTE).
Oregon State Univ., Corvallis. Water Resources

rch Inst.

Research Inst.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB87-165973/
AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G-1039-01, August 1986. 41
p, 1 fig. Contract No. 14-08-0001-G1039. USGS
Project No. G1039-01.

Descriptors: \*Water Research Institute, \*Research, \*Information transfer, \*Training, \*Oregon, Hydrologic budget, Water budget, Soil water, Transpiration, Juniper trees, Culverts, Roads, Drainage, Slope stability, Biodegradation, Microbial degradation, Groundwater pollution, Groundwater transport, Toxicity, Organic compounds, Salmon, Salmon,

#### Field 9—MANPOWER, GRANTS AND FACILITIES

### Group 9D-Grants, Contracts, and Research Act Allotments

monids. Minimum flow, Benthic environment, Regulated flow, Eutrophication, Cyanophyta, Iron bacteria, Algal growth.

bacteria, Algal growth.

The FY 1985 Oregon Water Resources Research Institute program included six projects concerned with water management of forest, range and agricultural zones, including the associated biological resources. These emphasized physical, chemical and biological processes for streams, lakes, groundwater zones and watersheds. Brief summaries of research findings are presented for each project. O2, Water Budget Model of Western Juniper; 03, Assessing Culvert Effectiveness in Mountainous Terrain; 04, Effect of Sorption on Bacterial Metabolism of Trace Toxicants in Groundwater Aquifers; 03, Determination of Minimum Flow Needs for Juvenile Salmonids in Central Oregon Streams; 06, Effects of Long-Term Regulated Flow on Community Composition of Stream Invertebrates; and 07, Development of Field Assay of Iron Limitation in Eutrophic Lakes. (Klingeman-Oregon St. Univ.)

FISCAL YEAR 1985 PROGRAM REPORT IRHODE ISLAND WATER RESOURCES CENTER),

Rhode Island Water Resources Center, Kingston. C. P. C. Poon.

C. P. C. Poon. Available from the National Technical Information Service, Springfield, VA 22161, as PB87-159406/. AS. Price codes: A03 in paper copy, A01 in micro-fiche. FY-1985 Institute Program Report, August 1986. 34 p. Contract No. 14-08-0001-G1042. USGS Project No. G1042-01.

Descriptors: \*Research, \*Information transfer, \*Training, \*Rhode Island, Modeling, Nitrate, Groundwater, Contamination, Turfgrasses, Remote sensing, Phenoxy pesticides, Non-point pollution, Acid precipitation, Trace metals, Computers, Databases, Information systems.

The State of Rhode Island is active in water re-The State of knoor island is active in water re-sources planning, development, and management activities which include legislation, upgrading of water and wastewater treatment facilities, institu-ing pretreatment programs and establishing task forces to study means of protecting watersheds in the state. Current and anticipated state water prob-lems are lack of cohesive planning among various state agencies; lack of comprehensive and defini-tive water policies; contamination of surface and state agencies; lack of comprehensive and definitive water policies; contamination of surface and groundwater by chemicals from agricultural, road-salting, septic tank and leach field cleanup; improperly measured landfills; and the unwillingness of some state agencies to share water resources data and to update their data management techniques. Five projects are completed covering the following subjects: (1) Modeling of Nitrate Contamination of Groundwater from Turfgrass Fertilization; (2) Geohydrological Study of Aquifers in Fractured Bedrock Using Geophysical and Remote Sensing Methods; (3) Waterborne Phenoxy Pesticide Movement form Turfgrass; (4) Metal Solublity and Leaching Caused by Acid Precipitation and Potential Impacts on the Scituate Reservoir; (5) Development of an On-Line Information System for Water Data Users. This center works closely with the R.I. Dept. of Environmental Management; Providence Water Supply Board; Subdistrict Office of USGS in Rhode Island, and other New England Water Resources Centers for program planning and research coordination. (USGS)

FISCAL YEAR 1985 PROGRAM REPORT (VIRGIN ISLANDS WATER RESOURCES RE-SEARCH CENTER),

Caribbean Research Inst., St. Thomas, VI. Water Resources Research Center. H. Smith

H. Smith.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB87-165940/
AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G-1050-01, July 1986. 24 p.
2 fig. Contract No. 14-08-0001-G1050. USGS
Project No. G1050-01.

Descriptors: \*Water Research Institute, \*Research, \*Information dissemination, \*Training, \*Virgin Is-

lands, Aquifer characteristics, Rock properties, Distribution system leakage, Saline water intru-sion, Sewage contamination, Water quality con-trol, Carbonate aquifers, Aquifer characteristics, Drilling samples, Diagenesis, Dolomite.

The quality of the potable water available for use in the Virgin Islands was a major focus of the Virgin Islands Water Resources Research Center's Program for the 1985 Fiscal Year. The limited groundwater in the Virgin Islands is susceptible to contamination and only the purp half water in the contamination not only through salt water intrusion but also by septic tank leakage. Aged water distribution lines, often in close proximity to sewage and salt water distribution lines, add to the reasons for concern over the quality of the water reasons for concern over the quality of the water being consumed. Projects investigated the quality and quantity of water in the principal aquifer in the Virgin Islands as well as in the public distribution systems. In an effort towards manpower develop-ment, a series of training seminars were held. Lastly, the third in a series of conferences focusing water resources of the Caribbean region, was con-vened to serve as a forum for the exchange of ideas and experiences among Caribbean water resources professionals and others concerned with the development of water resources of the region. (Smith-Virgin Islands Coll.) W87-09739

FISCAL YEAR 1985 PROGRAM REPORT (WEST VIRGINIA WATER RESEARCH INSTI-

TUTE), West Virginia Univ., Morgantown. Water Research In

C. R. Jenkins. C. N. Jenkins.
Available from the National Technical Information Service, Springfield, VA 22161, as PB87-174413/
AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G-1052-01, August 1986. 32 p. Contract No. 14-08-0001-G1052. USGS Project No. G1052-01.

Descriptors: \*Water Resources Institute, \*Research, \*Information transfer, \*Training, \*West Virginia, Acid mine drainage. Groundwater pollution, Microbiological studies, Geochemistry, Chemical properties, Alluvial deposits, Wetlands, Model studies, Bioassay, Carcinogens, Cattails, Water quality standards, Fish behavior, Information systems, Mapping.

The West Virginia State Water Research Institute program for 1985 was planned in collaboration with state and federal agencies. Seven research projects and one technology transfer project supporting 14 students were financed by the program: (1) Gary Bissonnette investigated the presence of standard plate count bacteria and opportunistic pathogens in rural groundwater supplies. Excessive total and feed colliform bacteria and Acineto. total and fecal coliform bacteria, and Acineto-bacter calcoaceticus have been found. (2) John Renton and Alfred Stiller studied acids producing potential of various rock lithologies. Partings produced the most acid while the seatearths have the highest acid production rate. (1) Robert Behling conducted a geologic analysis of the deposits in a wetland exposed during surface mining. Stream reconstruction techniques and water quality en-hancement in conjunction with reclamation are nancement in conjunction with retaination are expected to result from this study. (4) Henry Rauch studied completed surface mines to develop a method of predicting post mining acid drainage potential. Shale in overburden is an important neupotential small movements an important neutralizing agent. Updip mines produce poorer quality drainage than down dip mines. (5) David Hinton used fish embryos to test toxicity and carcinogenicity of groundwater. Fish have proven sensitive to contaminated groundwater. (6) David Samuel, John Sencindiver, and Henry Rauch are evaluating cattail marshes as a means of controlling sediment, iron and acid in surface mine drainage. Most sites showed increased pH for water flowing through a marsh. Cattails tolerate high iron concentrations and a low pH. (7) E.C. Keller, Jr. and J.A. Marshall investigated the impact of iron on the biota of West Virginia. At various levels of iron and aluminum no adult lethality was detected. Lethality to fry was detected. Egg survival was fairly high. (8) Robert Eli developed a computer based system capable of handling map data and other descriptive data related to streams and wa-

tersheds. Thirty-five people attended a seminar where the system was demonstrated. (Jenkins-WVU) W87-09740

FISCAL YEAR 1985 PROGRAM REPORT (HAWAII WATER RESOURCES RESEARCH

CENTER), Hawaii Univ. at Manoa, Honolulu. Water Resources Research Center.

L. S. LAU.

Available from the National Technical Information
Service, Springfield, VA 22161, as PB87-165999/
AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G-1013-01, September
1986, 31 p, 3 ref. Contract No. 14-08-0001-G1013.
ILSGS Project No. G1013-01 USGS Project No. G1013-01.

Descriptors: \*Water Research Institute, \*Research, \*Information transfer, \*Training, \*Hawaii, Water rights, Water supply development, Enteroviruses, Culturing techniques, Pathogens, Bacteriophage, Pesticide kinetics, Pesticides, Soil contamination, Leaching, Disinfection, Water quality, Viruses, Bacteria, Coliforms, Surface water, Wastewater, Metropolitan water management, Water use efficiency, Price, Time series analysis, Droughts, Water supply, Water demand.

Three events added substantially to existing prob-lems and issues that created a more than full agenda for water resources research in Hawaii: (1) the discovery of very low levels of pesticides in groundwater sources in the Pearl Harbor region that prompted the closure of several potable water wells; (2) the mandated state water code proposal, which was not passed by the state legislature and which proved to be most controversial during its preparation and in legislative deliberation; and (3) preparation and in legislative deliberation; and (3) mandatory water conservation restrictions imposed for Oahu and parts of neighbor islands by County water utilities. A water research agenda has been developed to address five principal water problems in Hawaii: overdraft of groundwater aquifers, coastal water quality and resources enhancement, in-stream uses and water values, state water allocain-stream uses and water values, state water allocation system, and subsurface water quality and contamination. Six research projects meaningfully developed and implemented the total program. An Evaluation of the Water Code Drafted by the Advisory Study Commission on Water Resources 1982-1985' (02) specifically addressed the policy issue of a proposed state water code. The impact of low rainfall was studied in 'Managing Urban Water Supply in Drought Emergencies: Economic, Administrative, and Other Strategies' (06). 'Desorption and Leachability of Residual DBCP and EDB in Soils and Saprolite' (04) contributed to the understanding of trace organic contamination of derstanding of trace organic contamination of Hawaii groundwater sources. Directly pertinent to Hawaii Water Agendas II and V were two Hawaii groundwater sources. Directly pertinent to Hawaii Water Agendas II and V were two projects: 'Development of a Highly Sensitive and Rapid Methodology for the Detection of Human Enteropathogenic Viruses in Water' (03) and Evaluation of Chlorine Dioxide as a Disinfectant of Bacteria and Viruses in Subsurface, Surface and Wastewater' (05). 'Atoll Groundwater Systems' (07) was conducted to provide a more scientifically sound basis for groundwater development on atolls. (Pujimura-Hawaii Univ.)

FISCAL YEAR 1985 PROGRAM REPORT (IOWA WATER RESOURCES RESEARCH IN-Iowa State Water Resources Research Inst., Ames. T. A. Austin.

A. Ausun.
 Available from the National Technical Information Service, Springfield, VA 22161, as PB87-177291/ AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G-1017-01. (September 1986). 29 p. Contract No. 14-08-0001-G-1017. USGS Project No. G1017-01.

Descriptors: \*Water Research Institute, \*Iowa, Education, Training, Information transfer, Algae, Ammonium, Nitrates, Groundwater recharge, Erosion, Rivers, Bank protection, Model studies

The Iowa State Water Resources Research Institute FY 1985 research program (University of

## SCIENTIFIC AND TECHNICAL INFORMATION—Field 10

Secondary Publication And Distribution—Group 10C

Iowa and Iowa State University) was funded by the U.S. Department of the Interior, Geological Survey (grant of \$109,000) and by an Iowa Legis-lature appropriation (\$128,000). The research pro-gram was centered in three areas critical to Iowa's natural resource program pertaining to water: Ni-trogen and Pesticide Transformation, Fate and Transport; Erosion; and Groundwater Manage-ment. Federal competitive funds were used to initi-ate two new projects relative to nitrogen/nitrate control in lowa streams, to complete one study of ate two new projects relative to nitrogen/nitrate control in Iowa streams, to complete one study of erosion, and to complete one study and continue another relative to groundwater management. Five studies were supported using state funding, all in the area of nitrogen/nitrate fertilizer control. A summary of each allotment project and source of the project progress or completion report is included in the Annual Report. (Austin-Iowa State Ilniv.) ed in the Univ.) W87-09742

FISCAL YEAR 1985 PROGRAM REPORT (COLORADO WATER RESOURCES RESEARCH INSTITUTE).

Colorado Water Resources Research Inst., Fort

Colins.

Available from the National Technical Information Service, Springfield, VA 22161, as PB87-177242/
AS. Price codes: A04 in paper copy, A01 in microfiche. Program Report G-1006-01, October 1986.
S8 p, 7 tab. Contract No. 14-08-0001-G1006. USGS Project No. G1006-01.

Descriptors: \*Water Research Institute, \*Colorado, \*Training, \*Research, \*Programs, \*Technology transfer, Water resources development, Administration, Irrigation wells, Groundwater pollution, Computer models, Finite element method, Groundwater recharge, Geochemistry, Recharge wells, Irrigation efficiency, Water transfer, Conjunctive use, Hydrologic model, Economic evaluation, South Platte, Water transfer, Colorado River, Phreatophytes, Evapotranspiration, Groundwater level, Consumptive use, San Luis Valley, Water conservation, Urban planning, Water requirements, Water supply.

The Colorado Water Resources Research Institute is the designated management center in Colorado for the Federal water research program. The Institute's Federal Fy1985 Program consisted of six research projects focused on the following Colorado problems: (1) Potential Groundwater Contamination from Chemigation; (2) Geochemistry of Aquifer Recharge in the Denver Basin; (3) Incentives for Improving Irrigation Efficiency in the South Platte Basin (Phase Pj. (4) Compensation for Basin-of-Origin for Water Exports; (5) Evapotranspiration of Phreatophytes in the Closed Basin, San Luis Valley (Phase II); and (6) The Impact of Water Conservation on Quality of Residential Lawns. In addition, the Institute received a state appropriation of \$67,000. This appropriation provided supplemental funding for the project on Evapotranspiration of Phreatophytes in the Closed Basin, San Luis Valley and for the completion and calibration of the South Platte Basin Simulation Model (SAMSON). The appropriation also helped provide an effective Institute technology transfer program, fully integrated with its water research The Colorado Water Resources Research Institute provide an effective Institute technology transfer program, fully integrated with its water research and development program. This includes: newsletters; three publications series; a 'library list' of new water resources research reports and publications; Project AWARE, designed to keep State and Fedral agency personnel aware of proposed research; public water policy education (programs including slide presentations); and workshops, seminars, and small group consultations involving potential users of research products. (Evans)

FISCAL YEAR 1985 PROGRAM REPORT (FLORIDA WATER RESOURCES RESEARCH CENTER), Florida Water Resources Research Center, Gaines-

J. P. Heaney.

Available from the National Technical Information Service, Springfield, VA 22161, as PB87-177267/ AS. Price codes: A02 in paper copy, A01 in micro-fiche. Program Report G-1010-01. November

1986. 17 p, 1 fig, 11 ref. Contract No. 14-08-0001-G1010. USGS Project No. G1010-0.

Descriptors: \*Water Research Institute, \*Research Descriptors: "water research histotic, "research, 'Information transfer, "Training, "Florida, Hydro-geology, Stormwater models, Biological waste treatment, Flood hazards, Water quantity, Water

The 1985 Annual Center Report for Florida describes current water problems and issues of Florida. Also, it contains synopees of the following studies which were supported by this program: 1. Computer-Aided Engineering Approach to Urban Flood Hazard Management, by Wayne Huber; 2. An Expert System for Integrated Flood Hazard Mitigation in Florida, by Soro Nnaji and Andrew Dzurik; and 3. Computer-Aided Approach to Agricultural Flood Hazard Management in Florida, by Lloyd Baldwin, Del Bottcher, and Ken Campby Lloyd Baldwin, Del Bottcher, and Ken Camp by Lloyd Baldwin, Del Bottcher, and Ken Camp-bell. Five reports were published in 1985. Runoff, bell. Five reports were published in 1985. Runoff, the semi-annual newaletter, was sent to over 1100 readers including 170 faculty. Lastly, technology transfer activities, cooperative arrangements with other groups, and training accomplishments are described. (Heaney-Florida WRRC)

FISCAL YEAR 1985 PROGRAM REPORT (MONTANA WATER RESOURCE CENTER). Montana Water Resources Research Center, Boze-

man.
Available from the National Technical Information
Service, Springfield, VA 22161, as PB87-166039/
AS. Price codes: A03 in paper copy, A01 in microfiche. Program Report G-1028-01, November
1986. 25 p. Compiled and edited by Howard S.
Peavy. Contract No. 14-08-0001-G-1028. USGS
Project No. G1028-01.

Descriptors: \*Water Research Institute. \*Research. \*Education, Training, Information transfer, Administration, Grants, Publications, Abstracts, Bib-

al program of the Montana University System Water Resource Center includes research, training and information transfer relating to water resources. The 1985 program included six research projects and three information transfer projects. Research projects addressed the broad issues of groundwater protection, conflicting water uses, transport of contaminants in surface and groundtransport of contaminants in surface and ground-waters, retention of water by agricultural soils, and the evaluation of analyses used to predict the ef-fects of mining on groundwater quality. The find-ings of these projects are reported in synoptic form. Three information transfer projects were included to put recently gained knowledge into the hands of waters users and managers in a timely fashion. These projects included (1) a water infor-mation system that compiled a bibliography of mation system that compiled a bibliography of water projects completed in the university system during the last ten years, and electronically filed during the last ten years, and electronically filed information and data from these projects; (2) a Reader's Service that provided access to the most recent literature to wide range of water users and managers in the state, (3) a project that will provide information on iron and manganese problems in well water to the owners of private and public wells, and (4) a short school on water resources for externess that practice water law. These projects wells, and (4) a short school on water resources for attorneys that practice water law. These projects provided training for future water professionals. A total of ten students at the undergraduate (1), mas-ters (7), and at the PhD. level, (2) in six different disciplines worked on Water Center projects. (Peavy-Montana State Univ.) W87-09745

METHOD FOR IDENTIFYING WATER RE-SOURCES RESEARCH NEEDS AND SETTING PRIORITIES AMONG THEM,

Tennessee Univ., Knoxville. Water Resources Research Center. For primary bibliographic entry see Field 6B. W87-09772

#### 10. SCIENTIFIC AND TECHNICAL INFORMATION

10C. Secondary Publication And Distribution

ORGANIC COMPONENTS IN BULK AND WET-ONLY PRECIPITATION, Oregon State Univ., Newport. Marine Science For primary bibliographic entry see Field 5A. W87-09628

SOURCES OF CLIMATOLOGIC, HYDROLOGIC, AND HYDRAULIC INFORMATION IN THE ILLINOIS RIVER BASIN, Geological Survey, Urbana, IL. Water Resources

Available from USGS, OFSS, Box 25425, Denver. CO 80225. USGS Open File Report 85-629, 1986. 113 p, 5 fig, 20 tab.

Descriptors: \*Data storage and retrieval, \*Data collections, \*Hydrologic data, \*Water data, \*Streamflow, \*Water quality, \*Sediment discharge, \*Floods, \*Illinois, \*Illinois River Basin, Hydrology, Hydraulics, Precipitation, Storms, Profiles, Illinois waterway.

Information on the sources of climatologic, hydrologic, and hydraulic data for the Illinois River basin is compiled in 20 tables. The study was conducted in cooperation with the U.S. Army Corps of Engineers, Rock Island District to provide information for their master regulation manual of the Illinois waterway. Eighteen governmental agencies were queried and a literature search was conducted to identify the source and availability of information on precipitation, major. availability of information on precipitation, major storms, streamflow, water quality and sediment, major floods, water-surface profiles, bridges and other structures, stream geometry, aerial photogra-phy, flood damages, Illinois river access facilities, Federal lands, and dam ratings. A selected bibliog-raphy of published reports was developed. (USGS) W87-09812

COMPILATION OF REFERENCES ON GEOLOGY AND HYDROLOGY OF THE SNAKE RIVER DRAINAGE BASIN ABOVE WEISER, IDAHO.

Geological Survey, Boise, ID. Water Resources Div. For primary bibliographic entry see Field 2F. W87-09824

GENE TRANSFER AMONG BACTERIA IN SOIL AND AQUATIC ENVIRONMENTS: A REVIEW Guelph Univ. (Ontario). Dept. of Environmental Biology.

For primary bibliographic entry see Field 2H. W87-09931

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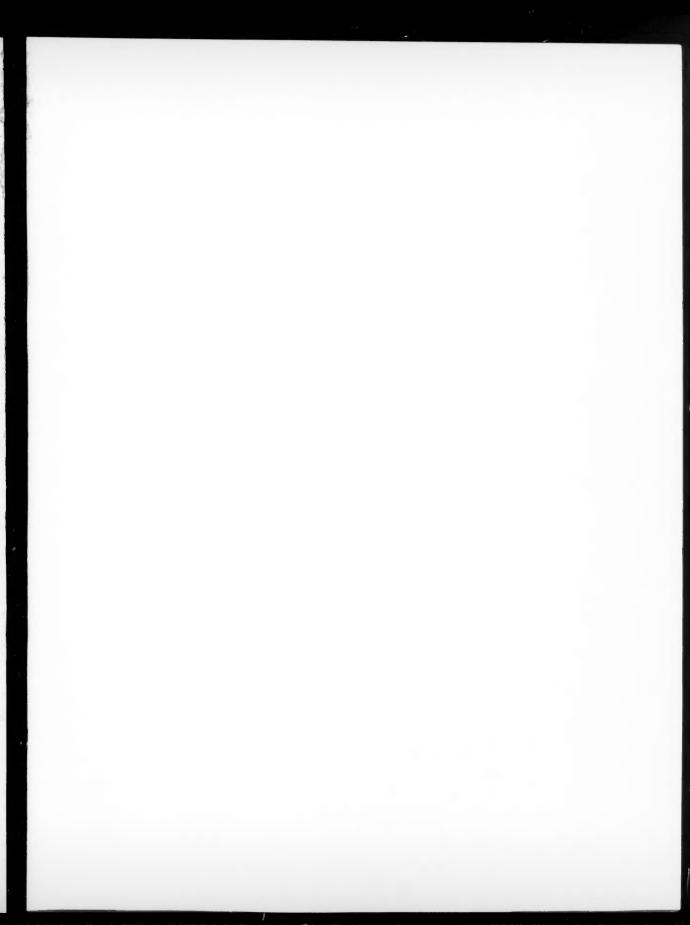
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W87-09963 7B W87-09964 7B	W87-10048 5D
W87-09965 7B	W87-10049 5D
W87-09966 7B	W87-10050 5D W87-10051 5D
W87-09967 7B W87-09968 7B	W87-10051 5D W87-10052 5D
W87-09969 7B	W87-10053 5D
W87-09970 7B	W87-10054 5D
W87-09971 7B	W87-10055 5B W87-10056 5D
W87-09972 7B W87-09973 7B	W87-10056 5D W87-10057 5D
W87-09974 7B	W87-10058 5D
W87-09975 2A	W87-10059 5D
W87-09976 2B	W87-10060 5D W87-10061 5D
W87-09977 7B W87-09978 7B	W87-10062 5D
W87-09979 2C	W87-10063 5D
W87-09980 7B	W87-10064 5D
W87-09981 7B W87-09982 2C	W87-10065 5D W87-10066 5D
W87-09983 7B	W87-10067 5D
W87-09984 7B	W87-10068 5D
W87-09985 7B	W87-10069 5D W87-10070 5D
W87-09986 7B W87-09987 7B	W87-10070 3D W87-10071 5D
W87-09988 7B	W87-10072 5D
W87-09989 7B	W87-10073 7B
W87-09990 2E	W87-10074 7B W87-10075 5C
W87-09991 7B W87-09992 7B	W87-10075 5C
W87-09993 7B	W87-10077 5A
W87-09994 2E	W87-10078 5C
W87-09995 7B W87-09996 7B	W87-10079 5C W87-10080 5C
W87-09997 7B	W87-10081 2H
W87-09998 7C	W87-10082 2H
W87-09999 2E	W87-10083 2H
W87-10000 2G W87-10001 7B	W87-10084 2H W87-10085 5C
W87-10002 7B	W87-10086 5D
W87-10003 7C	W87-10087 5D
W87-10004 7B	W87-10088 5D W87-10089 5D
W87-10005 7B W87-10006 7B	W87-10099 2H
W87-10007 7C	W87-10091 2H
W87-10008 2F	W87-10092 2H
W87-10009 7B W87-10010 7B	W87-10093 2H W87-10094 5A
W87-10010 /B W87-10011 2F	W87-10094 3A W87-10095 2H
W87-10012 7B	W87-10096 2H
W87-10013 7B	W87-10097 2H
W87-10014 7B W87-10015 2H	W87-10098 2H W87-10099 2H
W87-10015 2H W87-10016 7C	W87-10100 2H
W87-10017 7B	W87-10101 8A
W87-10018 7C	W87-10102 8A
W87-10019 7B	W87-10103 8G W87-10104 8G
W87-10020 7B W87-10021 7B	W87-10104 8G

W87-10106	5F
W87-10107	8A
W87-10108	7C
W87-10109	5G
W87-10110	5D
W87-10111	5D
W87-10112	8C



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#### NORTH AMERICAN CONTINENT PRICE SCHEDULE

Customers in Canada, United States, and Mexico please use this price schedule; other addresses, write for PR-360-4.

MICROFICHE	/PAPER COPY	DISKETTES	MAGNETIC TAPES
A01 \$6.50	E01\$7.50	001\$50 00	T01\$156.00
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A03 11.95	E0311.00	D03 125.00	T03380.00
404-A05 13.95	E0413.50	D04 175.00	T04400.00
A06-A09 18.95	E0515.50	005 225.00	T05500.00
A10-A1324.95	E0618.00	D06 275.00	106600.00
A14-A1730.95	E0720.50	D07 325.00	T07700.00
A18-A2136.95	E0823.00	D08375.00	T08800.00
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A99*	E1028.00	D10 475.00	T101,000.00
	E1130.50	D11 525.00	T111,100.00
	E1233.00	D12 575.00	T121,200.00
HO145.00	E1335.50	D13 625.00	T131,300.00
NO248.00	E1438.50	014 675.00	T141,400.00
	£1542.00	D15725.00	T151,500.00
	£1646.00	D16 775.00	T161,600.00
	£1750.00	D17 825.00	T171,700.00
	E1854.00	D18 875.00	1181,800.00
	E1960.00	D19 925.00	T191,900.00
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